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# APPENDIX A SAMPLING RESULTS KENNECOTT UTAH COPPER MAGNA, UTAH

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May 1997



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INCORPORATED

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## EXECUTIVE SUMMARY

Samples of tailings were collected and evaluated for acidification potential during 1996 as required by Appendix A and Appendix B of the Ground Water Discharge Permit, revised September 4, 1996. Samples were collected from the test fill, and the lower, middle, and upper embankment of the existing impoundment. Samples were also collected from both the Magna and Copperton Concentrators, the power plant, and the slag plant. All of the tailings samples were analyzed for ABA by KEL using a modification of the Sobek Method (Sobek et al., 1978) as specified by KEL SOP 5010.03.

A comparison was made between the results from the previous sampling event, conducted as part of the initial tailings characterization (SMI, 1995a), and the results of the most recent data collection program. The ABA values of the samples collected in 1995 during the acidification study are generally in agreement with those collected during the Appendix A sampling. The results from this data collection effort support the results and conclusions made during the initial characterization in 1995.

One of the main reasons that this sampling program was conducted was a concern as to whether or not an adequate number of samples had been collected initially to fully characterize the ABA characteristics of the embankment. A statistical evaluation of the adequacy of sampling indicates that the number of samples collected is sufficient to estimate the population means with a 95% level of confidence.

Tailings from the slag plant and the power plant have little potential for produce acid. These samples have ABA values ranging from 147 tons  $\text{CaCO}_3/\text{kton}$  for the one sample of slag tailings to a mean value of 236 tons  $\text{CaCO}_3/\text{kton}$  for the two samples collected from the power plant.

The analytical results show that the overall ABA (net neutralizing potential) is becoming more positive with passing time as evidenced by: (1) increasing ABA values from the lower to upper embankment, (2) an increase in ABA from deep levels to shallow levels in the borehole samples, and (3) the high ABA of tailings now discharging from the Copperton Concentrator (19 tons  $\text{CaCO}_3/\text{kton}$ ).

**APPENDIX A SAMPLING RESULTS  
KENNECOTT UTAH COPPER  
MAGNA, UTAH**

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## 1.0 INTRODUCTION

The following report discusses the analytical results for tailings samples collected during 1996 at the Kennecott Utah Copper tailings facility as required by Appendix A and Appendix B of the Ground Water Discharge Permit, revised September 4, 1996. Samples were collected from the test fill, and the lower, middle, and upper embankment of the existing impoundment. Samples were also collected from both the Magna and Copperton Concentrators, the power plant, and the slag plant.

## **2.0 SAMPLE COLLECTION**

### **2.1 Sampling Locations**

#### **2.1.1 Test Fill Samples**

Samples were collected from three depths (1, 4, and 8 feet below ground surface) within each of the four test plots in the test fill. A total of 12 samples were collected from the test fill.

Additional samples of test fill tailings were collected during oxygen profile measurements conducted by Schafer and Associates (SA) in August 1996. These samples were composite samples collected from depths of 0 to 2 feet, 2 to 4 feet, and 4 to 6 feet from plots 2, 3, and 4 for a total of 9 samples. These results are included in this discussion.

#### **2.1.2 Upper, Middle, and Lower Embankment Samples**

Fourteen evenly spaced transects were established around the perimeter of the embankment (Figure 1). The transects were located so as to avoid the 22 sampling transects that governed the previous sampling (Shepherd Miller, Inc. [SMI] and SA, 1995) (Figure 2). At each transect, a sample was collected from the lower, middle, and upper region of the embankment at a depth of 6 to 12 inches.

Six additional samples were also collected from the upper embankment in an area approximately 3 feet in diameter. Three samples were taken from a depth of 0 to 6 inches and three samples from a depth of 6 to 12 inches. These samples were used to evaluate the inherent variability of tailings deposited in the same small area over a short period of time.

Sampling points along the transects in the lower, middle, and upper embankment were generally selected at random so as to not bias the sampling results. However, in some locations visual inspection of the selected sampling point revealed that the material was not tailings but was most likely fill or imported material. In this case, the sampling point was moved a few feet up or down the transect to avoid sampling an area that was obviously not tailings.

### 2.1.3 Miscellaneous Samples

Samples of tailings were also collected from the tailings discharge points for the Copperton and Magna Concentrators as well as for the slag and power plant tailings by Kennecott personnel. A total of eight and seven samples were collected from the Copperton and Magna Concentrators, respectively, between January and December of 1996. One sample of slag tailings, collected in July 1996, and two tailings samples from the power plant, collected in April and August 1996, were also collected.

## 2.2 Sample Handling

Tailings samples were collected using a trowel or hand shovel, dried, and placed in sealed plastic containers for storage. Deeper subsurface samples from the test fill were collected using a hand auger. Splits of samples to be analyzed for bacterial enumeration were placed in pre-sterilized sample containers (provided by Stewart Environmental), placed in an ice-filled cooler, and shipped by next-day air to Stewart Environmental in Fort Collins, Colorado. The samples that were utilized for the acid/base accounting (ABA), mineralogy, and paste pH testing were returned to SMI, where they were dried and homogenized. Samples were split using a riffle splitter and sent to the appropriate laboratory for testing (Kennecott Environmental Laboratory (KEL) and Energy Laboratories, Inc. (ELI) for ABA testing, and Stewart Environmental for bacterial enumeration). Sample mineralogy was determined by SMI. Splits of all samples have been dried and archived and will be stored for at least 2 years. The sampling locations were marked in the field with a stake.

To prevent cross-contamination between sampling locations, all sampling equipment was decontaminated between sampling points. Decontamination consisted of rinsing the sampling equipment successively with detergent, tap water, and deionized water. Equipment used for bacterial sampling was also disinfected with alcohol between sample locations.

### 3.0 SAMPLE ANALYSIS

#### 3.1 Acid/base Accounting

All of the tailings samples were analyzed for ABA by KEL using a modification of the Sobek Method (Sobek et al., 1978) as specified by KEL SOP 5010.03. KEL was the primary laboratory for ABA testing, and splits of samples were sent to ELI to validate the results obtained by KEL. The certificates of analyses for the testing performed by KEL and ELI are included in Appendices A and B, respectively.

Acid/base accounting includes analysis for sulfur species (total sulfur, pyritic sulfur, and residual sulfur) and acid-neutralizing capacity. The specific components are as follows:

Acidification potential (AP): The AP is reported in units of tons of equivalent  $\text{CaCO}_3$  present per 1,000 tons of material (tons  $\text{CaCO}_3/\text{kton}$ ). It is based on pyrite oxidation stoichiometry, in which every gram of sulfide sulfur requires 3.125 grams of limestone to neutralize it. Therefore, the AP is calculated by:

$$\% \text{ pyrite} \times 31.25 = \text{AP (tons CaCO}_3/\text{kton)}$$

Neutralization potential (NP): The NP is determined by addition of a known volume of a standard acid, followed by back titration with a standard base. The NP is provided primarily by carbonate minerals but may also include hydroxides and various aluminosilicates. The NP is also reported in units of tons  $\text{CaCO}_3/\text{kton}$  and is calculated as follows:

$$\% \text{ equivalent CaCO}_3 \times 10 = \text{NP (tons CaCO}_3/\text{kton)}$$

Acid/Base Account (ABA): ABA represents the balance between the acidification potential (AP) and the neutralization potential (NP) and is calculated by:

$$\text{ABA} = \text{NP} - \text{AP (tons CaCO}_3/\text{kton)}$$

### 3.2 Other Tests

Paste pH values were measured on all samples from the test fill and the upper, middle, and lower embankments.

Eight samples from the lower embankment were also selected to evaluate the mineralogy to determine if there is any detectable relationship between mineralogy and degree of acidification. Analysis was done by X-ray diffraction (XRD) and optical microscopy.

Six samples from the lower embankment were selected to determine the viability and abundance of *Thiobacillus ferrooxidans*, which is the primary bacterium responsible for acidification of sulfide-bearing tailings. The bacteria were cultured by an SMI subcontractor, Stewart Environmental Company (Fort Collins, Colorado). This information was examined to determine if any relationship exists between the abundance of the bacteria and the current degree of acidification.

### 3.2 Quality Assurance/Quality Control

An important component of any testing program is the implementation of measures to evaluate both the precision and accuracy of the tests being performed. To meet this objective, sample sets included quality control and quality assurance (QA/QC) procedures. Precision was determined by using sample splits (at least one for every 10 unknown samples). Accuracy was evaluated by using a laboratory control sample (at least one for every 10 unknown samples) prepared during the previous study, and a laboratory control sample obtained from an outside source (one least one for every 10 unknown samples). The laboratory control samples were previously prepared by making well-mixed composite samples of coarse-grained tailings underflow collected from the cyclone.

A total of 23 of the samples that were analyzed by KEL were also submitted to ELI for duplicate analysis. Included in the sample set that was sent to ELI were sample splits (one least one for every 10 unknown samples) and the same two reference materials that were analyzed by KEL (one of each for every ten unknown samples). The results for the ELI QA/QC are included in Appendix C.

Overall, the precision of the analyses conducted by KEL is acceptable due to the fact that:

1. Relative percent differences (RPDs) for sample splits were generally less than  $\pm 35\%$  for all components (total sulfur, pyritic sulfur, and equivalent  $\text{CaCO}_3$ ).
2. The analyses of the standards were within an acceptable range of values.

Visual examination of the test results from KEL for pyritic sulfur suggests that the values are lower than the same samples analyzed by ELI. However, application of the Student's t-test indicates that there is no statistical difference between the means of the two sets of analyses at the 95% confidence interval. The mean pyritic sulfur from the KEL analyses was  $1.1 \pm 0.68\%$  pyritic sulfur (mean  $\pm 1$  standard deviation), while the mean from ELI was  $1.2 \pm 0.70\%$  pyritic sulfur, corresponding to a difference in ABA units of 3 tons  $\text{CaCO}_3/\text{kton}$ .

Four of the 23 split samples analyzed for percent equivalent  $\text{CaCO}_3$  by both KEL and ELI had an RPD value greater than  $\pm 35\%$ . Analyses performed by KEL had a mean value of  $2.1 \pm 2.1$  percent equivalent  $\text{CaCO}_3$  (% eq.  $\text{CaCO}_3$ ), while the mean value for the same samples from ELI was  $2.4 \pm 1.8$  % eq.  $\text{CaCO}_3$ , corresponding to a difference in ABA units of 3 tons  $\text{CaCO}_3/\text{kton}$ . Application of the Student's t-test shows that there is no statistical difference between the means of the two sets of analyses at the 95% confidence interval.

A full discussion of the QA/QC results is included in Appendix C, including the results for the reference material.

## 4.0 ANALYTICAL RESULTS

A comparison was made between the statistical results from the previous sampling event, conducted as part of the initial tailings characterization (SMI, 1995a), and the statistical results of the most recent data collection effort. In this report, the initial tailings characterization data collected in 1994 and 1995 are referred to as Data Set #1 while the most recent results are referred to as Data Set #2. All of the ABA results are presented in Table 1.

Results are reported as the mean values, plus and minus one standard deviation (mean  $\pm$  1 standard deviation). Also reported for each data set is range which represents the range of values for which there is a 95% confidence level that the true mean of the entire population falls within.

During the previous study conducted in 1994 and 1995, a total of 104 samples were collected from the lower, middle, and upper portions of the post-1974 embankment along 22 transect lines, as well as from the test fill (Figure 2).

For each data set, there were a few analytical results that fell outside the normal distribution of results for a given data set; therefore, an outlier test was used to evaluate the validity of outlying data. The statistical outlier test used was the Grubbs Test (EPA, 1989). The purpose of the outlier test was to determine whether there is statistical evidence that an observation that appears to be extreme does not fit the distribution of the rest of the data. If a suspect observation was identified as an outlier, it was removed from the data set.

In most cases, the outliers resulted from an extremely high neutralizing potential ( $>10\%$  eq.  $\text{CaCO}_3$ ). Based on the QA/QC results of the 1994/1995 samples, these high neutralizing potential values in Data Set #1 did not result from analytical error but are most likely the result of intermixing of either native borrow material ("float") brought up on the embankment during construction of the embankment or borrow material used as fill. Inclusion of these high ABA values in the data set would have created two distinct populations: one population of tailings and one population of other material. Therefore, these data points were removed from the data set in order to evaluate the statistics of the tailings only; however, the highly neutralizing material is

beneficial in the overall ABA potential of the embankment because it adds neutralizing potential to local regions of the embankment.

One of the main reasons that this sampling program was conducted was a concern as to whether an adequate number of samples had been collected initially to fully characterize the ABA characteristics of the embankment. Therefore, a statistical evaluation was conducted on the combined data set (after removal of outliers) to determine sampling adequacy. This was done using Stein's method, as outlined in Addendum Number 1 (dated May 7, 1996), in the memorandum dated May 16, 1996 from Mr. John Whitehead of the Ground Water Protection Section.

Stein's method utilized the statistics of the given data population (mean, inverse of the F-probability distribution, and the variance) to calculate the number of samples that are required to adequately characterize the population at a 95% confidence interval. A comparison of calculated number of samples to the actual number of samples collected can be used to evaluate whether more samples need to be collected.

#### **4.1 Upper Embankment**

A total of 14 samples were collected from the upper portions of the Kennecott tailings embankment during this sampling event and 26 were collected during the earlier 1994/1995 study. In addition to the 14 transect samples, six samples were collected from a small area (approximately 3 feet in diameter) in the upper embankment.

Outlier tests performed on both data sets did not indicate that any outliers existed in either data set from the upper embankment. This was expected because most "float" (material brought up from lower levels during embankment construction) occurs in the middle and lower embankment.

As shown in Table 1, the mean ABA for the upper embankment measured in Data Set #1 was 4.8  $\pm$  22 tons CaCO<sub>3</sub>/kton (mean  $\pm$  1 standard deviation) with a 95% confidence interval of -3.8 to

13. The average ABA for Data Set #2 was  $-3.3 \pm 13$  tons  $\text{CaCO}_3/\text{kton}$  with a 95% confidence interval of -10 to 3.3 tons  $\text{CaCO}_3/\text{kton}$ . As is shown in Figure 3, the 95% confidence intervals about the mean overlap, suggesting that the two data sets were drawn from the same population of samples of samples.

One difference between the two data sets appears to be a combination of a higher pyrite content in Data Set #1 (mean = 0.83% pyritic sulfur) than in Data Set #2 (mean = 0.79% pyritic sulfur), which results in a difference in ABA units of 1.2 tons  $\text{CaCO}_3/\text{kton}$ . A second difference is that Data Set #1 shows a higher % eq.  $\text{CaCO}_3$  (mean = 3.06% eq.  $\text{CaCO}_3$ ) than Data Set #2 (mean = 2.13% eq.  $\text{CaCO}_3$ ), resulting in a difference in ABA units of 9.3 tons  $\text{CaCO}_3/\text{kton}$ . These two together results in an observed difference between the mean ABA values between the two data sets of 8 tons  $\text{CaCO}_3/\text{kton}$ .

Combining the two data sets results in a mean ABA of  $2.0 \pm 20$  tons  $\text{CaCO}_3/\text{kton}$ , with a 95% confidence interval of -4.1 to 8.1 tons  $\text{CaCO}_3/\text{kton}$  (Table 1). As more samples are added to the sample set initially represented by Data Set #1, the calculated mean will eventually approach the true mean of the entire population. Thus, the addition of Data Set #2 to Data Set #1 has changed the mean of the entire population from 4.8 tons  $\text{CaCO}_3/\text{kton}$  (with a 95% confidence interval of -3.8 to 13 tons  $\text{CaCO}_3/\text{kton}$ ) to 2.0 tons  $\text{CaCO}_3/\text{kton}$  (with a 95% confidence interval of -4.1 to 8.1 tons  $\text{CaCO}_3/\text{kton}$ ).

A total of 40 samples have been collected during the two sampling events. Sampling adequacy using Stein's method indicates that a total of 15 samples would be required. Therefore, an adequate number of samples have been collected to establish the mean with a 95% level of confidence.

As mentioned earlier, a total of six samples were collected from a small area (approximately 3 feet in diameter) in the upper embankment to evaluate the inherent variability of tailings in a small area. The mean ABA ( $\pm$  one standard deviation) for these samples was  $-9.4 \pm 8.3$  tons/kton. The ABA values ranged from a low of -17 tons/kton to a high of 2 tons/kton with a 95% confidence interval about the mean (-9.4) of -16 to 2.7 tons  $\text{CaCO}_3/\text{kton}$ . The standard

deviation observed in these six samples is only slightly smaller than those observed for samples collected from each region of the tailings impoundment during this sampling event. This indicates that the variability observed within a small area in the upper embankment is similar to the variability observed throughout the upper portion of the impoundment, indicating, that the tailings impoundment as a whole is a relatively homogeneous system.

Approximately 31% of the samples from Data Set #1 are below an ABA guideline value of -10 tons  $\text{CaCO}_3/\text{kton}$  (the same ABA guideline as used in the previous study [SMI, 1995a]) while 21% of the samples from Data Set #2 are below this value. This would indicate that approximate 30% of the samples from the upper embankment samples are potentially acidic.

#### 4.2 Middle Embankment

A total of 14 samples were collected from the middle portions of the Kennecott tailings embankment during this sampling event and 36 were collected during the 1994/1995 study.

Outlier tests performed on Data Set #1 identified six samples as outliers, but no outliers were identified in Data Set #2. The six outliers were identified in Data Set #1; four had high carbonate contents (20.5, 16.8, 15.6, and 11.5 % eq.  $\text{CaCO}_3$ ) and two had high pyritic sulfur contents (2.10 and 2.49 % pyritic sulfur).

As mentioned earlier, these samples with high carbonate values are most likely the result of intermixing of either native borrow material ("float") brought up on the embankment during construction of the embankment, borrow material used as fill, or past soil amendments. This high neutralizing material is beneficial in the overall ABA potential of the embankment because it adds neutralizing potential to local regions of the embankment.

The mean ABA measured in Data Set #1 from the middle portion of the embankment was  $3.4 \pm 25$  tons  $\text{CaCO}_3/\text{kton}$  (mean  $\pm 1$  standard deviation) with a resulting 95% confidence interval of -4.8 to 12 tons  $\text{CaCO}_3/\text{kton}$ . The average ABA for Data Set #2 was  $-13 \pm 16$  tons  $\text{CaCO}_3/\text{kton}$  with a confidence interval of -22 to -5.3 tons  $\text{CaCO}_3/\text{kton}$ . In this case, the 95% confidence

intervals do not quite overlap, suggesting two populations of samples. Examination of Data Set #1 reveals that many of the high ABA values are concentrated between Transects 14, 15, and 16, along the north east corner of the impoundment (Figure 2). These six samples had a mean ABA of  $42 \pm 24$  tons  $\text{CaCO}_3/\text{kton}$ . In contrast, during the Appendix A sampling, only one sample was located in this area (AT6-M) (Figure 1), with a relatively low ABA value. Therefore, the failure of the two data sets to coincide (within a 95% confidence interval) is probably due to differences in the density of sampling in the northeast corner of the impoundment between the two sampling events.

The differences between these two data sets appears to be a combination of a lower pyrite content in Data Set #1 (mean = 0.72% pyritic sulfur) than in Data Set #2 (mean = 0.97% pyritic sulfur) which results in a difference in ABA units of 7.8 tons  $\text{CaCO}_3/\text{kton}$ . Also, the % eq.  $\text{CaCO}_3$  is higher in Data Set #1 (mean = 2.6% eq.  $\text{CaCO}_3$ ) than in Data Set #2 (mean = 1.7% eq.  $\text{CaCO}_3$ ) which results in a difference in ABA units of 9 tons  $\text{CaCO}_3/\text{kton}$ . These two together results in an observed difference in the mean ABA values between the two data sets of 17 tons  $\text{CaCO}_3/\text{kton}$ .

Combining the two data sets (49 values) results in a mean ABA of  $-1.4 \pm 26$  tons  $\text{CaCO}_3/\text{kton}$ , with a 95% confidence interval of -8.8 to 6.0 tons  $\text{CaCO}_3/\text{kton}$ .

A total of 49 samples have been collected during the two sampling events. Sampling adequacy using Stein's method indicates that a total of 23 samples would be required. Therefore, an adequate number of samples have been collected to estimate the mean with a 95% level of confidence.

Approximately 37% of the samples from Data Set #1 are below an ABA guideline value of -10 tons  $\text{CaCO}_3/\text{kton}$  while 43% of the samples from Data Set #2 are below this value. This would indicate that approximate 40% of the samples from the upper embankment samples are potentially acidic. This estimate does not include any of the high ABA regions that were removed from the data sets as outliers; inclusion of these data points would decrease the estimated percentage of materials that are potential acidic.

### 4.3 Lower Embankment

#### 4.3.1 ABA Testing

A total of 14 samples were collected from the lower portion of the Kennecott tailings embankment during this sampling event and 37 were collected during the 1994/1995 study.

Outlier tests performed on Data Set #1 identified ten samples as outliers, of which all ten had high ABA values. Three outliers were identified in Data Set #2. The ten outliers in Data Set #1 with high ABA values resulted from high carbonate values in these samples and probably represents material brought up from below during construction of the embankment which is beneficial. More outliers were identified in this portion of the embankment than in the middle and upper. This is expected since dam construction in the lower portions of the embankment would have brought up more material from below than in the middle and upper levels.

The mean ABA measured in Data Set #1 was  $-7.3 \pm 14$  tons  $\text{CaCO}_3/\text{kton}$  (mean  $\pm 1$  standard deviation) with a resulting 95% confidence interval of -12 to -2.2 tons  $\text{CaCO}_3/\text{kton}$ . The mean ABA for Data Set #2 was  $-11 \pm 15$  tons  $\text{CaCO}_3/\text{kton}$  with a confidence interval of -20 to -2.4 tons  $\text{CaCO}_3/\text{kton}$ . As is shown in Figure 3, the 95% confidence intervals about the mean overlap suggesting that the two data sets were drawn from the same population of samples of samples.

The differences in these two data sets appears to be a combination of a lower pyrite content in Data Set #1 (mean = 0.55% pyritic sulfur) than in Data Set #2 (mean = 0.60% pyritic sulfur) which results in a difference in ABA units of 1.6 tons  $\text{CaCO}_3/\text{kton}$ . At the same time, % eq.  $\text{CaCO}_3$  is higher in Data Set #1 (mean = 1.0% eq.  $\text{CaCO}_3$ ) than in Data Set #2 (mean = 0.7% eq.  $\text{CaCO}_3$ ) which results in a difference in ABA units of 3 tons  $\text{CaCO}_3/\text{kton}$ . These two together results in an observed difference in the mean ABA values between the two data sets of 4.6 tons  $\text{CaCO}_3/\text{kton}$ .

Combining the two data sets resulted in a mean ABA of  $-8.4 \pm 14$  tons  $\text{CaCO}_3/\text{kton}$  with a 95% confidence interval of -13 to -4.0 tons  $\text{CaCO}_3/\text{kton}$ .

A total of 38 samples have been collected during the two sampling events. Sampling adequacy using Stein's method indicates that a total of 8 samples would be required. Therefore, an adequate number of samples have been collected to estimate the mean with a 95% level of confidence.

Approximately 33% of the samples from Data Set #1 are below an ABA guideline value of -10 tons  $\text{CaCO}_3/\text{kton}$  while 36% of the samples from Data Set #2 are below this value. This would indicate that approximate 34% of the samples from the upper embankment samples are potentially acidic. This estimate does not include any of the high ABA regions that were removed from the data sets as outliers; inclusion of these data points would decrease the estimated percentage of materials that are potential acidic.

#### 4.3.2 Mineralogy

Eight samples from the lower embankment of the Kennecott tailings impoundment (samples AT1-L, AT2-L, AT3-L, AT4-L, AT8-L, AT9-L, AT-11L, and AT-13L) were examined by optical thin-section microscopy and XRD to determine the mineralogy and degree of weathering.

The eight samples were similar in mineralogic content. The samples were primarily composed of quartz and feldspar, with minor biotite and muscovite. Additionally, accessory minerals (accounting for up to 10%) included: iron oxides, sulfides, calcite (and possibly dolomite?), epidote, and clay minerals, including chlorite and kaolinite. All of the samples contained between approximately 0.5% to 4% opaque minerals (sulfides and iron oxides). The sulfide minerals were predominantly pyrite ( $\text{FeS}_2$ ) and chalcopyrite ( $\text{CuFeS}_2$ ) with a minor amount of bornite ( $\text{Cu}_5\text{FeS}_4$ ). Iron oxide minerals included hematite, goethite, and various hydrated iron oxides, oxyhydroxides, and oxyhydroxo-sulfates. XRD analysis of a clay fraction separate ( $<2\ \mu\text{m}$ ) of one sample (AT4-L) also indicated the presence of jarosite [potassium jarosite,  $\text{KFe}_3(\text{SO}_4)_2(\text{OH})_6$  and/or hydronium jarosite,  $\text{HFe}_3(\text{SO}_4)_2(\text{OH})_6$ ], as well as clays.

The abundance and degree of alteration of pyrite grains varied between samples. For example, sample AT11-L contains  $<1\%$  sulfides, and these grains showed little alteration; in contrast,

sample AT13-L contained approximately 4% sulfides, comprised of fairly large altered and unaltered pyrite grains, with unaltered grains dominant. The remaining samples showed moderate to major alteration of pyrite, with a continuous rim of iron oxide surrounding most pyrite grains.

The feldspars were predominantly potassium feldspar and showed internal weathering (sericitization) that likely occurred prior to milling. Biotite grains generally showed minor weathering. Chalcopyrite is often found within or next to quartz and generally shows a minor degree of weathering. Bornite and chalcopyrite are often found together.

The amount of carbonates present varied between samples. Calcite (and possibly dolomite?) is generally very fine-grained, with the exception of a single large grain with rhombic cleavage that was observed in sample AT13-L (possible representing carbonate "float"). Several of the samples contained grains of quartz interbedded with finer-grained calcite.

As shown in Table 2, paste pH values of the samples varied over a wide range, reflecting different mineralogy and degree of alteration. Paste pH appears to be controlled by the amount of carbonate minerals present; for example, the three samples that had paste pH values below 4 (AT1-L, AT3-L, and AT11-L) contained as little as 0.4% eq.  $\text{CaCO}_3$  or less (as measured by ABA). The other five samples from the lower embankment tested for mineralogy had paste pH values above 7 and  $\text{CaCO}_3$  concentrations between 1.0% and 8.7%. The paste pH of sample AT11-L, which contained very few sulfides and showed little alteration, was 3.42. ABA tests confirmed that this sample contained very little pyrite (0.19%) and almost no carbonate minerals (<0.2% eq.  $\text{CaCO}_3$ ). In contrast, sample AT13-L, which contained about 4% sulfides, had a paste pH of 7.61; pyrite content was measured to be 3.02% and with 2.2% eq.  $\text{CaCO}_3$ . The remaining samples, which showed oxidation of the pyrite, contained varying amounts of pyrite and equivalent  $\text{CaCO}_3$ .

#### 4.3.3 Bacterial Enumeration

Samples collected from the lower section of the embankment were analyzed for the viability and abundance of *Thiobacillus ferrooxidans*, which is the primary bacterium responsible for acidification of sulfide-bearing tailings. Bacteria were detected by allowing a sample to contact distilled water for a period of 24 hours, decanting the resulting liquid into a test tube, and inoculating the liquid with a ferrous-iron-rich growth medium. The test tubes were allowed to stand for a period of a few days to a week until a change in color to orange was noted. The change in color was a positive indication of the presence of *Thiobacillus ferrooxidans*. The more rapid the change in color, the more active was the bacteria population. The results are given in Table 3.

*Thiobacillus ferrooxidans* is an obligate acidophile that has a pH range of 1.0 to 3.5, and an optimal pH near 2.0. Therefore, it is not surprising that those samples with paste pH value greater than 5 did not show any detectable amount of the bacteria (Table 3). What is surprising is that, for the sample (sample AT13-L) with a pH of 2.2, no bacteria were detected.

At the present time it is not known why there are no bacteria detected in five of the six samples tested. Possible explanations include analytical error or possibly that the samples may have been too dry at the time of collection to sustain a bacterial colony.

#### 4.4 Test Fill

A total of 21 samples were collected from the test fill during this sampling event and seven were collected during the 1994/1995 study.

Outlier tests performed on Data Set #1 identified one sample with a low ABA value. Four outliers were identified in Data Set #2; three outliers had high carbonate values and one had a high pyritic sulfur content. Two of the samples with high carbonate values were from Test Plot #3 which was amended with limestone which may have contaminated the samples during sample collection. The other sample with high carbonate value was from Test Plot #2; this test plot was

not embedded with limestone, therefore, there is no obvious reason for this high value in this sample.

The mean ABA measured in Data Set #1 was  $0.93 \pm 7.4$  tons  $\text{CaCO}_3/\text{kton}$  (mean  $\pm 1$  standard deviation) with a resulting 95% confidence interval of -4.5 to 6.4 tons  $\text{CaCO}_3/\text{kton}$ . The mean ABA for Data Set #2 was  $-2.0 \pm 11$  tons  $\text{CaCO}_3/\text{kton}$  with a confidence interval of -7.3 to 3.3 tons  $\text{CaCO}_3/\text{kton}$ . Within the precision of the two data sets, the values are essentially the same.

Combining the two data sets (28 samples) results in a mean ABA of  $-1.2 \pm 10$  tons  $\text{CaCO}_3/\text{kton}$  with a 95% confidence interval of -5.4 to 3.0 tons  $\text{CaCO}_3/\text{kton}$ .

#### 4.5 Additional Samples

The eight tailings samples collected from the Copperton Concentrator had a mean percent pyrite content of  $0.51 \pm 0.35\%$  pyritic sulfur, and a mean equivalent carbonate value of  $0.35 \pm 0.27\%$  eq.  $\text{CaCO}_3$ , resulting in a mean ABA value of  $19 \pm 9.4$  tons  $\text{CaCO}_3/\text{kton}$ .

The seven tailings samples collected from the Magna Concentrator had a mean percent pyrite content of  $1.7 \pm 0.78\%$  pyritic sulfur, and a mean carbonate values of  $3.5 \pm 1.8\%$  eq.  $\text{CaCO}_3$ , resulting in a mean ABA value of  $-16 \pm 21$  tons  $\text{CaCO}_3/\text{kton}$ .

The Copperton Concentrator, which produces the majority of the tailings discharged to the impoundment, receives the "typical" ore extracted from the Bingham Pit for processing and therefore produces a tailings that is more consistent. On the other hand, the Magna Concentrator receives ore that is more difficult to process thus producing a tailings that is more variable. This can be seen in the ABA values of tailings produced by each concentrator (Figure 4). The tailings produced by the Copperton Concentrator between February and December 1996 ranged from a low ABA of 4.4 tons  $\text{CaCO}_3/\text{kton}$  to a high of 30 tons  $\text{CaCO}_3/\text{kton}$  with a standard deviation of 9.4 tons  $\text{CaCO}_3/\text{kton}$ . Tailings produced by the Magna Concentrator ranges from a low of -56 tons  $\text{CaCO}_3/\text{kton}$  to a high of 5.2 tons  $\text{CaCO}_3/\text{kton}$  with a standard deviation of 21 tons  $\text{CaCO}_3/\text{kton}$  (Figure 4).

The tailings are produced at a ratio of approximately 80 parts Copperton tailings to 20 parts Magna tailings (Appendix A, Morrison Knudsen water balance design criteria, SMI 1995b). As the new expansion is brought on-line, production from the Copperton Concentrator will increase while production from Magna Concentrator will be maintained at the same level. By the year 2000, 86% of the tailings solids will be from the Copperton Concentrator, resulting in increasingly favorable ABA values in the new expansion.

These two tailings streams are discharged separately into the impoundment and, therefore, the low ABA Magna Tailings would most likely form discrete layers or lenses in the higher ABA Copperton Tailings. This may help explain why there are layers of acidified tailings surrounded by near-neutral tailings in the existing impoundment. The layers of acidified tailings within the existing impoundment may be Magna Tailings that have weathered and acidified, surrounded by layers of Copperton Tailings that have sufficient carbonate content to prevent the formation of acidic conditions.

The adequacy of sampling can be evaluate using Stein's method for both the Copperton and the Magna Concentrator. For the samples collected from the Copperton Concentrator, the estimated number of samples required using Stein's method is five; a total of eight sample have been collected from Copperton. This indicates that an adequate number of samples have been collected. For the sample collected from the Magna Concentrator, the estimate number of samples required is 26; a total of seven samples have been collected which indicates that sampling of the Magna Tailings should continue.

It is anticipated that, given the low variability of ABA values of the tailings produced by the Copperton Concentrator and the results of Stein's method for determining sampling adequacy, sampling from this process stream can be reduced to quarterly basis to monitor any spatial trends. The ABA values of the tailings produced by the Magna Concentrator will continue to be variable producing a wide range of ABA values; based on results of Stein's method for determining sampling adequacy, sampling should continue on a monthly basis for at least one more year.

These ABA values collected directly from the Copperton Concentrator are much more positive than the results for the existing impoundment described earlier, indicating that the remaining portions of the upper embankment and the new expansion will have increasingly favorable positive ABA values.

Tailings from the slag plant and the power plant have little potential for produce acid. These samples have ABA values ranging from 147 tons  $\text{CaCO}_3/\text{kton}$  for the one sample of slag tailings to a mean value of 236 tons  $\text{CaCO}_3/\text{kton}$  for the two samples collected from the power plant. The high ABA values are a results of a low pyritic sulfur content (0.02 to 0.06% pyritic sulfur) and a high carbonate content (15 to 31% eq.  $\text{CaCO}_3$ ).

#### 4.6 Discussion of Results

In all of the sampling locations, with the exception of the test fill, the mean carbonate content reported in Data Set #1 was higher than in Data Set #2. The observed difference in carbonate values could possibly be the result of a bias introduced during sampling site selection, as discussed earlier.

The reasons for the observed differences in pyritic sulfur content (higher values observed in Data Set #2 than in Data Set #1) between sampling events is not clear. The QA/QC results (See Table 8 in Appendix C) indicate a bias toward lower values from KEL compared to ELI; however, the results reported here have higher values from KEL (Data Set #2) than ELI (Data Set #1). It is possible that the same bias introduced in the first sampling event (i.e. sampling non-tailings material containing high carbonate values) may have also caused an overall lowering of mean pyrite values for each portion of the embankment in Data Set #1 (Table 1).

One noticeable trend in the ABA results of the embankment samples is the general increase in ABA values from the lower embankment to the upper embankment (Figure 5). This same trend can be observed in the borehole samples collected during the original evaluation (SMI, 1995a) as demonstrated in Figure 6. These two boreholes are typical of the trends observed in the other boreholes. In addition, as described above, recent tailings from the Copperton Concentrator

show the most positive ABA values yet encountered. This increase in ABA values with time, both within the existing impoundment and in the new tailings, indicate that the North Expansion will be built using tailings with ABA values more positive and more favorable than those observed in the existing impoundment.

A comparison of the histograms for each of the data sets show similar trends in data. Between the ABA ranges of -50 and 20 tons  $\text{CaCO}_3/\text{kton}$ , the histograms are comparable. There does appear to be another population of data between 30 and 50 tons  $\text{CaCO}_3/\text{kton}$  in Data Set #1 which does not appear in Data Set #2. An examination of Data Set #1 shows that the data in this range (30 to 50 tons  $\text{CaCO}_3/\text{kton}$ ) is generally found in the upper and middle regions of Transects 9, 10, and 11 and Transects 15 and 16. Therefore, the failure of the two data sets to coincide (within a 95% confidence interval) is probably due to differences in the density of sampling in these two locations of the impoundment between the two sampling events.

The mean ABA for all samples (test fill and the upper, middle, and lower embankment) measured in Data Set #1 was  $0.56 \pm 21$  tons  $\text{CaCO}_3/\text{kton}$  (mean  $\pm 1$  standard deviation) with a resulting 95% confidence interval of -3.7 to 4.8 tons  $\text{CaCO}_3/\text{kton}$ . The mean ABA for Data Set #2 was  $-7.0 \pm 14$  tons  $\text{CaCO}_3/\text{kton}$  with a confidence interval of -11 to -3.3 tons  $\text{CaCO}_3/\text{kton}$ . As is shown in Figure 3, the 95% confidence intervals about the mean overlap suggesting that the two data sets were drawn from the same population of samples of samples.

## 5.0 HUMIDITY CELL SAMPLES

Kinetic testing will be conducted as specified in Appendix A of the Ground Water Discharge Permit, revised September 4, 1996. The kinetic tests will be performed on samples to establish what ABA values will become acid producing. Samples were selected based on ABA and paste pH. As per Appendix A of the Ground Water Discharge Permit, the samples were selected to span a range of ABA values between +10 and -10 tons  $\text{CaCO}_3/\text{kton}$ . Samples having a low pH were excluded. Those samples recommended for humidity cell testing are presented in Table 4.

## 6.0 CONCLUSIONS

- Analysis of the tailings show that the ABA (net neutralizing potential) is becoming more positive with passing time as evidenced by:
  1. Increasing ABA values from the lower to upper embankment
  2. An increase in ABA from deep levels to shallow levels in the borehole samples
  3. The current high ABA values of tailings collected from the Copperton Concentrator (mean value of +19 tons  $\text{CaCO}_3/\text{kton}$ ).
- The range of mean ABA values between the samples collected in 1995 during the acidification study and the Appendix A sampling are generally in agreement (except for samples collected from the middle embankment). The mean ABA values of samples collected from the upper and lower embankment, and the test fill, as part of the Appendix A sampling, are lower than those samples collected during the previous study.
- The 95% confidence interval about the mean for the middle embankment from Data Set #1 (-4.8 to 12 tons  $\text{CaCO}_3/\text{kton}$ ) does not overlap that from Data Set #2 (-22 to -5.3 tons  $\text{CaCO}_3/\text{kton}$ ). This may have been the result of a lower density of samples in an area of high ABA at the northeast corner of the existing impoundment during Appendix A sampling.
- The mean ABA for the seven samples collected from the Magna Concentrator was negative (ABA = -16 tons  $\text{CaCO}_3/\text{kton}$ ). However, these tailings comprise only 20% of the total discharge to the tailings impoundment. The Copperton Concentrator, with a mean ABA of 19 tons  $\text{CaCO}_3/\text{kton}$ , contributes 80% of the tailings to the impoundment. Taking a weighted average of these two process streams results in a total ABA of 12 tons  $\text{CaCO}_3/\text{kton}$ , and by the year 2000, 86% of the tailings will be from the Copperton Concentrator, resulting in an increase in overall tailings ABA in the expansion.
- Tailings from the slag plant and the power plant have little potential for produce acid. These samples have ABA values ranging from 147 tons  $\text{CaCO}_3/\text{kton}$  for the one sample of slag

tailings to a mean value of 236 tons  $\text{CaCO}_3/\text{kton}$  for the two samples collected from the power plant.

- A statistical evaluation of the adequacy of sampling using Stein's method indicates that, for all locations on the tailings impoundment, the number of samples collected is sufficient to estimate the population means with a 95% level of confidence.
- Statistical analysis showed that some of the highest ABA values (typically  $>100$  tons  $\text{CaCO}_3/\text{kton}$ ) in the lower and middle embankment are not part of the overall tailings population. These outliers are likely the result of the intermixing of either native borrow material ("float") brought up on the embankment during construction of the embankment or borrow material used as fill. Inclusion of these high ABA values in the data set would have created two distinct populations: one population of tailings and one population of other material. Therefore, these data points were removed from the data set in order to evaluate the statistics of the tailings only; however, the highly neutralizing material is beneficial in the overall ABA potential of the embankment because it adds neutralizing potential to local regions of the embankment.
- It is anticipated that, given the low variability of ABA values of the tailings produced by the Copperton Concentrator and the results of Stein's method for determining sampling adequacy, sampling from this process stream can be reduced to quarterly basis to monitor any spatial trends. The ABA values of the tailings produced by the Magna Concentrator will continue to be variable producing a wide range of ABA values; based on results of Stein's method for determining sampling adequacy, sampling should continue on a monthly basis for at least one more year.

## 7.0 REFERENCES

- Shepherd Miller, Inc. and Schafer and Associates. 1995a. *Acidification Potential of the Kennecott Tailings*, prepared for Kennecott Utah Copper Corp., May 18.
- Shepherd Miller, Inc. (SMI). 1995b. Mass Balance Report, prepared by Shepherd Miller, Inc. for Kennecott Utah Copper Corporation, October 27.
- Sobek, A.A., W.A. Schuller, J.R. Freeman, and R.M. Smith. 1978. Field and Laboratory Methods Applicable to Overburdens and Minesoils. U.S. Environmental Protection Agency, EPA 600/2-78-054. Cincinnati, Ohio.
- U.S. Environmental Protection Agency (USEPA). 1989. Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Interim Final Guidance. EPA-530-SW-89-026. Office of Solid Waste, Waste Management Division, Washington, D.C. February.

Table 1 Statistics summary table - Acidification Report (SMI, 1995) and Appendix A sampling (outliers removed)

Location		% pyritic sulfur		% eq. CaCO <sub>3</sub>		ABA (tons CaCO <sub>3</sub> /kton)			
		Mean	S.D.	Mean	S.D.	N	Mean	S.D.	95% confidence interval
Upper Embankment	Data Set #1	0.83	0.49	3.1	1.7	26	4.8	22	-3.8 to 13
	Data Set #2	0.79	0.49	2.1	0.88	14	-3.3	13	-10 to 3.3
	Combined	0.87	0.49	2.8	1.43	40	2.0	20	-4.1 to 8.1
Middle Embankment	Data Set #1	0.72	0.44	2.6	2.9	35	3.4	25	-4.8 to 12
	Data Set #2	0.97	0.63	1.7	1.7	14	-13	16	-22 to -5.3
	Combined	0.79	0.52	2.3	2.6	49	-1.4	26	-8.8 to 6.0
Lower Embankment	Data Set #1	0.55	0.38	1.0	0.78	27	-7.3	14	-12 to -2.2
	Data Set #2	0.60	0.44	0.75	0.52	11	-11	15	-20 to -2.4
	Combined	0.56	0.41	0.91	0.73	38	-8.4	14	-13 to -4.0
Test Fill	Data Set #1	0.38	0.15	1.3	0.78	7	0.93	8.3	-4.5 to 6.4
	Data Set #2	0.61	0.36	1.7	0.54	17	-2.0	11	-7.3 to 3.3
	Combined	0.54	0.32	1.6	0.61	24	-1.2	10	-5.4 to 3.0
All Samples	Data Set #1	0.67	0.45	2.2	2.2	95	0.56	21	-3.7 to +4.8
	Data Set #2	0.74	0.51	1.6	1.1	56	-7.0	14	-11 to -3.3
	Combined	0.70	0.47	2.0	1.9	151	-2.2	19	-5.3 to 0.80

Table 2 Paste pH values for lower, middle, and upper transects

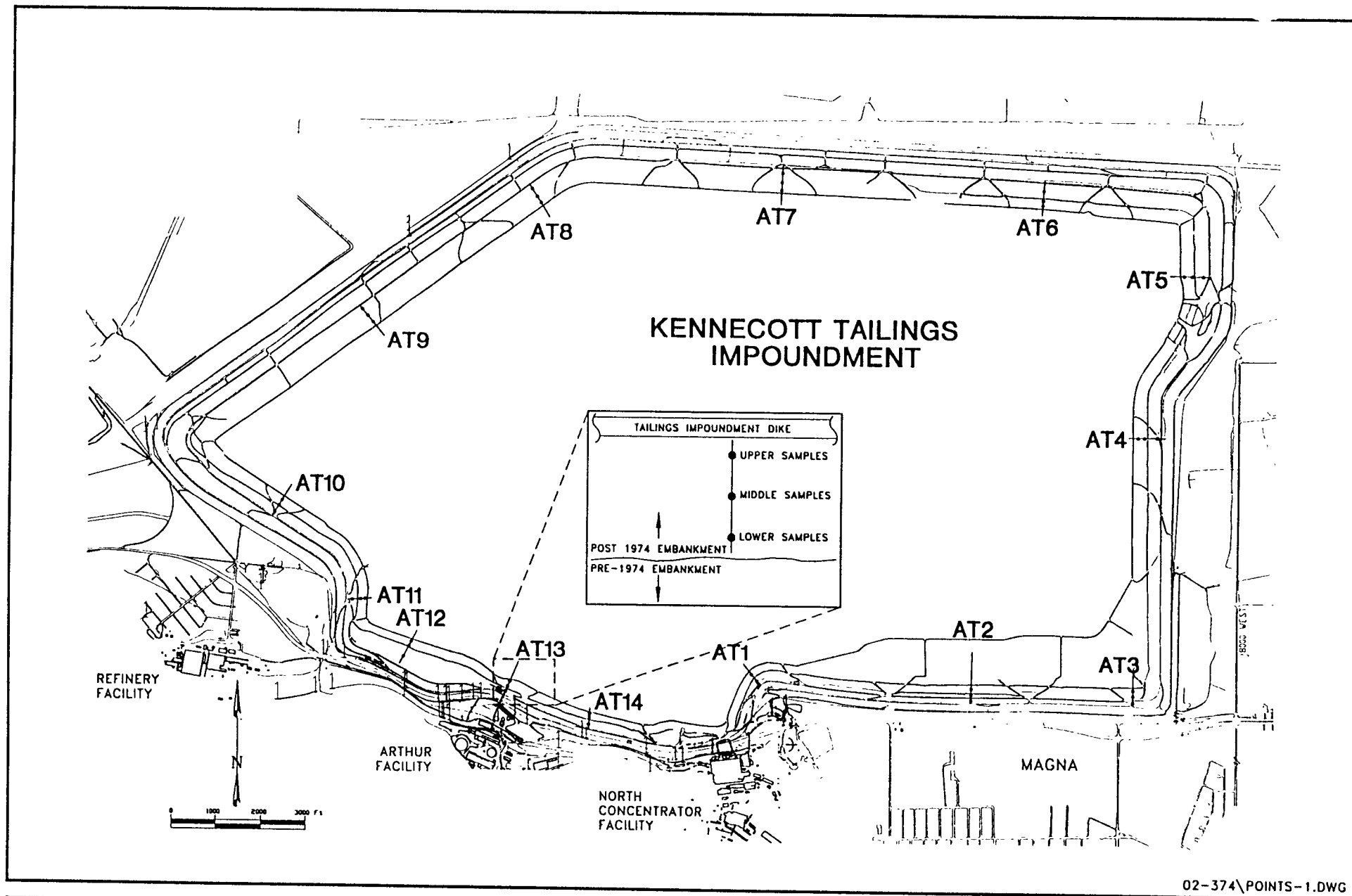
Transect	Paste pH		
	Lower	Middle	Upper
AT 1	3.8	7.5	7.8
AT 2	7.5	2.8	6.3
AT 3	3.0	7.3	5.8
AT 4	7.6	7.5	7.4
AT 5	5.3	3.1	7.5
AT 6	7.1	2.9	7.5
AT 7	7.5	2.5	7.4
AT 8	7.1	2.8	7.4
AT 9	7.5	6.7	7.6
AT 10	5.2	7.2	7.5
AT 11	3.4	3.1	7.4
AT 12	3.7	7.0	7.6
AT 13	7.6	7.2	7.2
AT 14	2.2	5.4	7.8

**Table 3      Results of bacterial enumeration testing**

Sample ID	Paste pH	Bacterial Concentration (bacteria/mL)
AT2-L	7.5	<1
AT4-L	7.6	<1
AT8-L	7.1	<1
AT10-L	5.2	<1
AT12-L	3.7	200-2,000
AT14-L	2.2	<1

**Table 4      List of recommended samples for humidity cell testing**

Sample ID	NP	AP	ABA
	tons CaCO <sub>3</sub> /kton		
AT11-U	16	26	-10
AT12-M	14	23	-9
AT9-L	14	17	-3
AT6-U	25	26	-1
AT6-L	12	7	5
AT1-M	45	35	10



02-374\POINTS-1.DWG

FIGURE 1  
APPENDIX A SAMPLING LOCATIONS

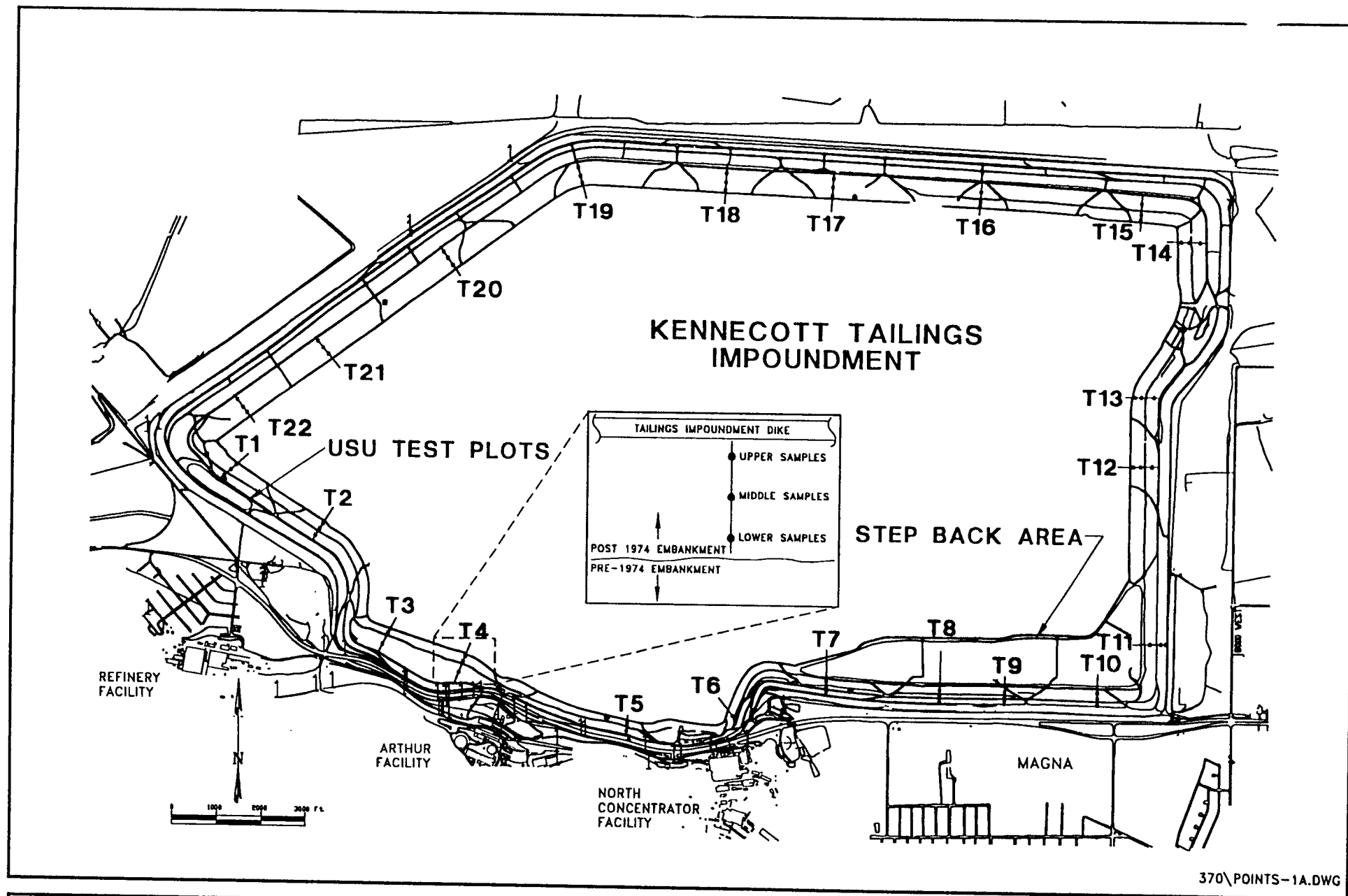


FIGURE 2  
EMBANKMENT SAMPLING LOCATIONS, MARCH 1994

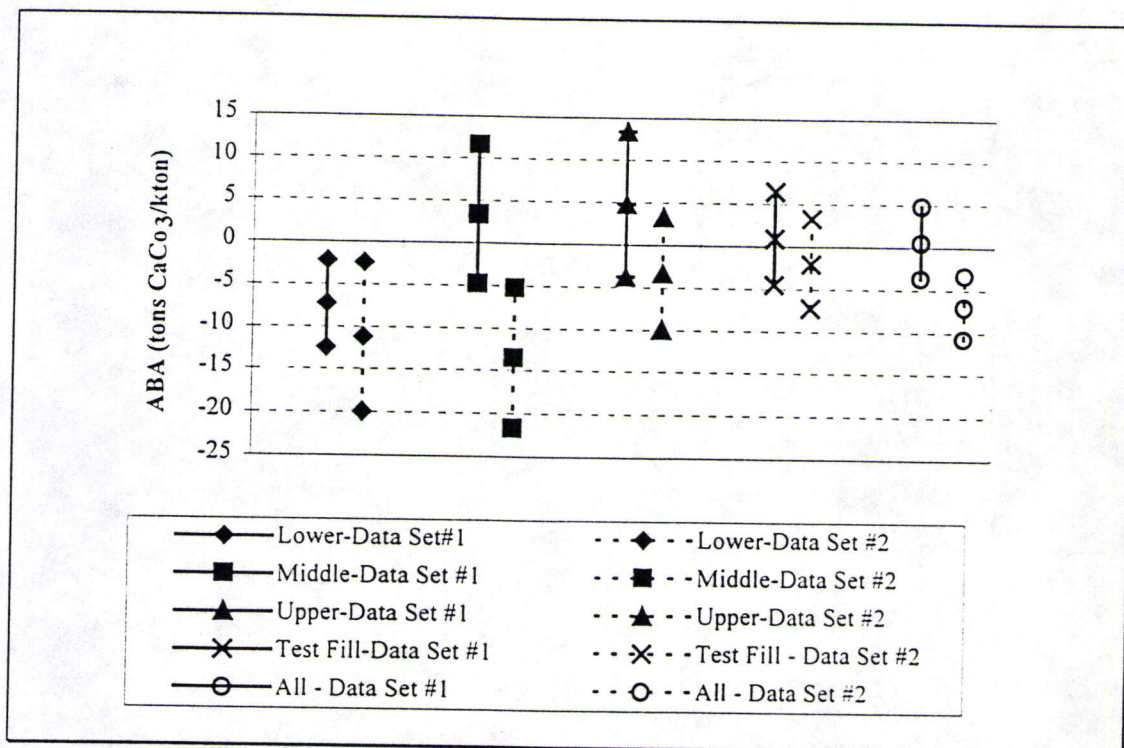


Figure 3 95% confidence interval about the mean for both data sets for the test fill and the lower, middle, and upper embankments

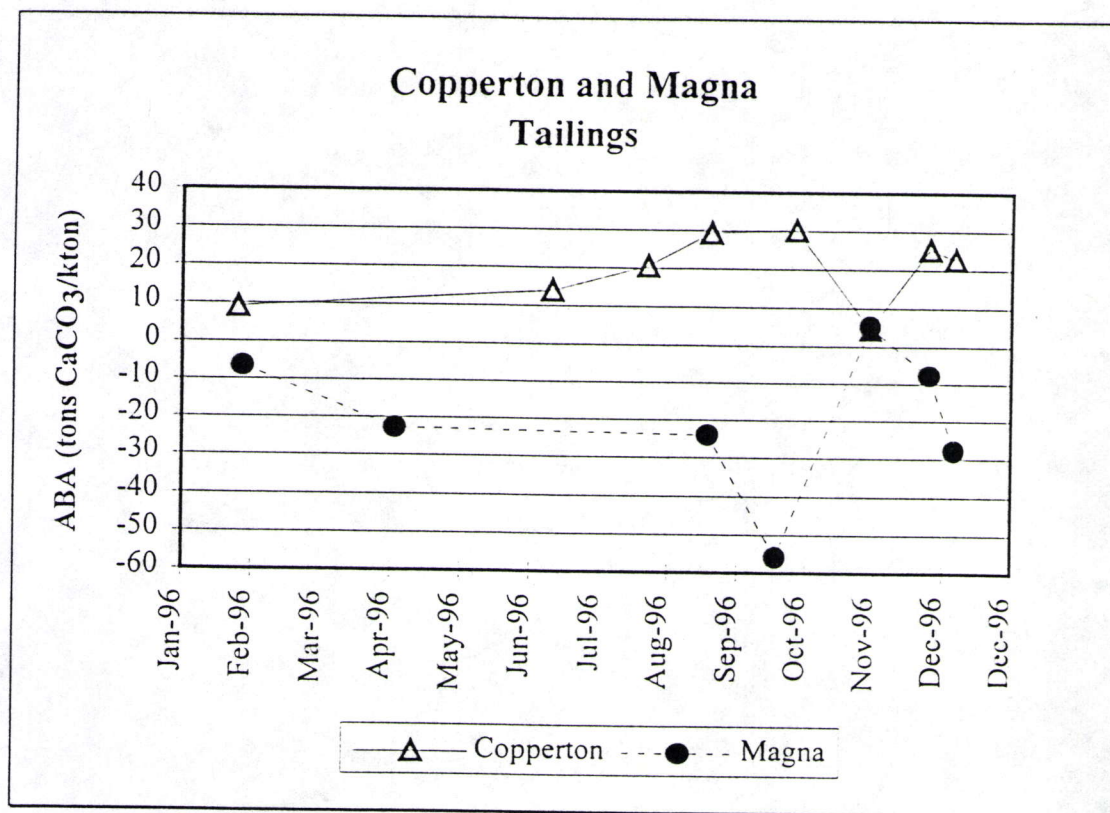


Figure 4 ABA values versus time for tailings produced by the Copperton and Magna Concentrators

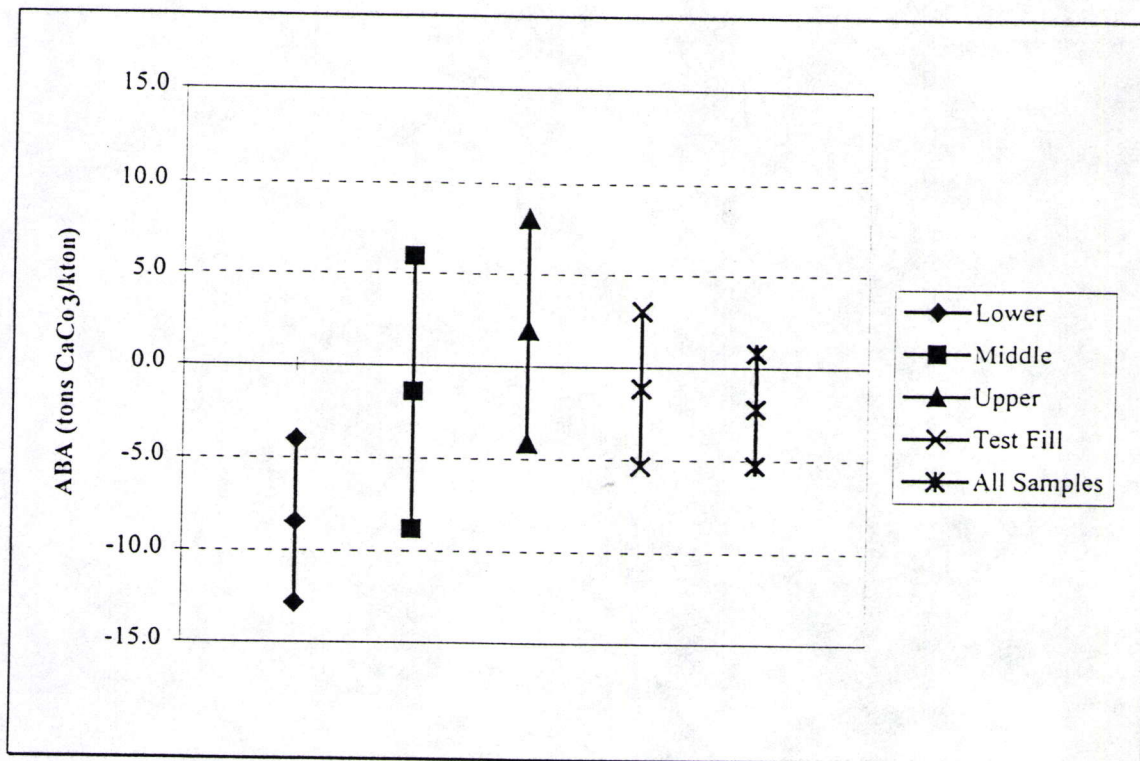


Figure 5 95% confidence interval about the mean for combined data set for the test fill and the lower, middle, and upper embankments

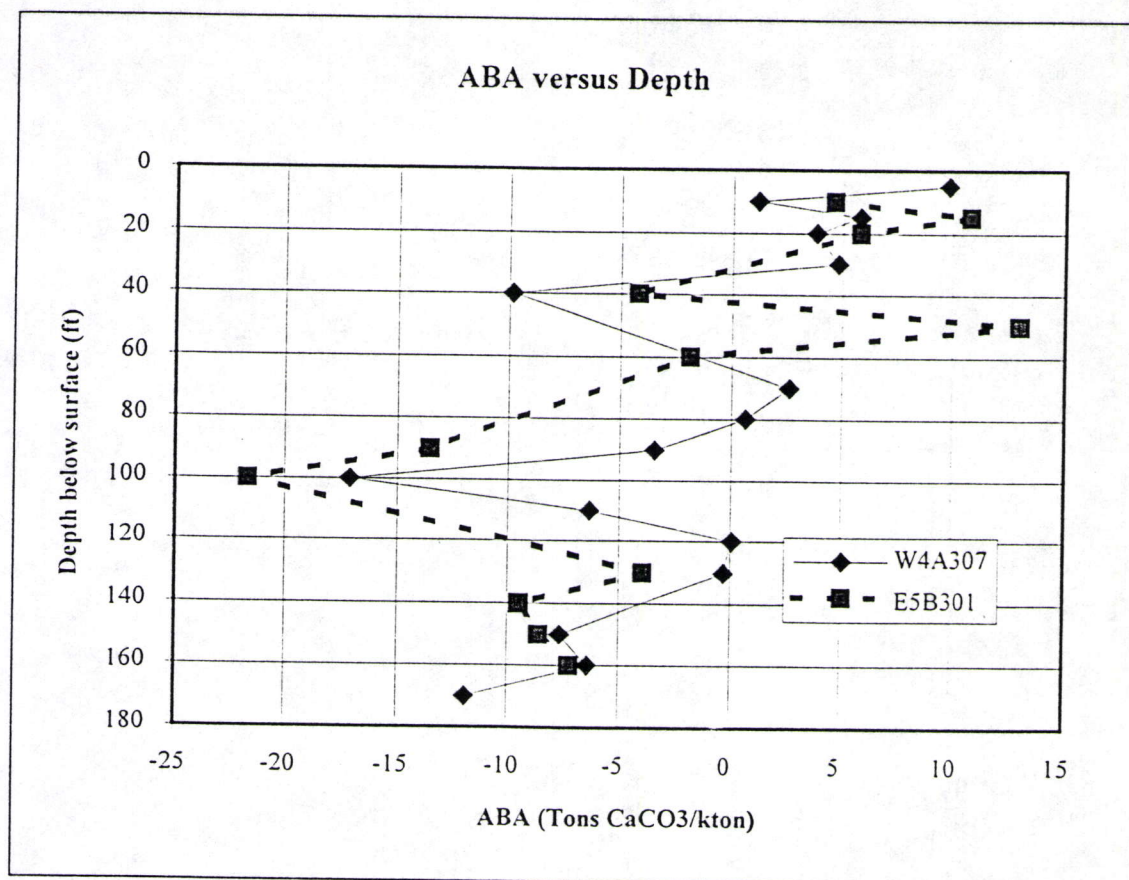


Figure 6 ABA results versus depth for borehole samples W4A307 and E5B301

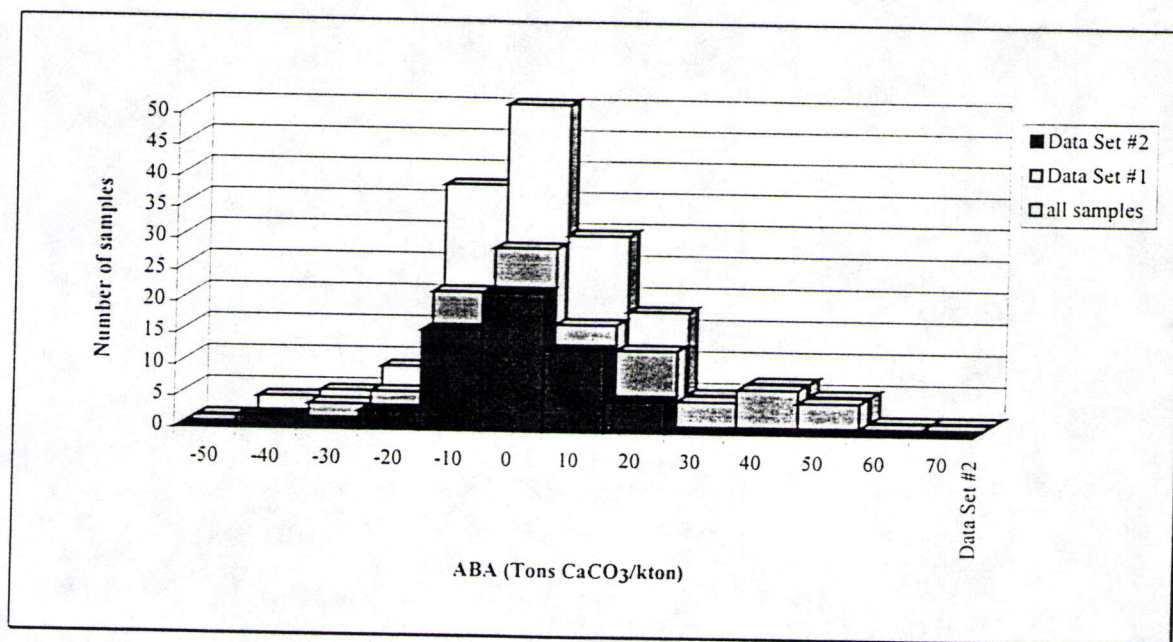


Figure 7 Histogram for Data Set #1, Data Set #2, and combined (outliers removed from data sets)

**APPENDIX A**

**CERTIFICATES OF ANALYSIS:  
KENNECOTT ENVIRONMENTAL LABORATORY**

**Table A-1 Key to KEL Sample Number, Sample Description, and SMI/SA Sample ID**

KEL Sample Number Numb -	KEL Sample Description	SMI/SA Sample ID	Date Collected
AF00150	BCP1483A	copperton conc.	9/27/96
AF00172	BCP1483A	copperton conc.	10/30/96
AE16866	BCP1483A	copperton conc.	11/25/96
AE17512	BCP1483A	copperton conc.	12/6/96
AF00181	MCP1480	power plant	4/16/96
AF00173	MCP1484A	magna tails	10/30/96
AE16865	MCP1484A	magna tails	11/25/96
AE17511	MCP1484A	magna tails	12/6/96
AF00174	SMP-1481A	slag tailings	7/31/96
AF00177	MCP1480A	power plant	8/23/96
AF00183	BCP1483A	copperton conc.	1/30/96
AF00186	BCP1483A	copperton conc.	6/13/96
AF00187	BCP1483A	copperton conc.	7/25/96
AF00190	BCP1483A	copperton conc.	8/21/96
AF00198	Ref-GMT	Lab-QA/QC	
AF01268	MCP1484A	magna tails	2/1/96
AF01269	MCP1484A	magna tails	4/7/96
AF01272	MCP1484A	magna tails	8/20/96
AF01273	MCP1484A	magna tails	9/19/96
AF01274	TL960132	plot 3 0-2	8/15/96
AF01275	TL960133	plot 3 2-4	8/15/96
AF01276	TL960134	plot 3 4-6	8/15/96
AF01277	TL960135	plot 2 0-2	8/15/96
AF01278	TL960136	plot 2 2-4	8/15/96
AF01279	TL960137	plot 2 4-6	8/15/96
AF01280	TL960138	plot 4 0-2	8/15/96
AF01281	TL960139	plot 4 2-4	8/15/96
AF01282	TL960140	plot 4 4-6	8/15/96
AF01283	TL960141	hot spot 0-2	8/15/96
AF01284	TL960142	hot spot 2-4	8/15/96
AF01285	TL960143	hot spot 4-6	8/15/96
AF01286	TL960144	stepback south 0-2	8/16/96
AF01287	TL960145	stepback south 2-4	8/16/96
AF01288	TL960146	stepback south 4-6	8/16/96
AF01289	Blank	Lab-QA/QC	8/16/96

**Table A-1 Key to KEL Sample Number, Sample Description, and SMI/SA Sample ID  
(continued)**

KEL Sample Number Number	KEL Sample Description	SMI/SA sample ID	Date Collected
AF01290	TL960146 - dup	Lab-QA/QC	8/16/96
AF01291	ref-GMT	Lab-QA/QC	8/16/96
AF01292	TL960147	new stepback 0-2	8/16/96
AF01293	TL960148	new stepback 2-4	8/16/96
AF01294	TL960149	new stepback 4-6	8/16/96
AF01295	TL960150	old tails 0-2	8/16/96
AF01296	TL960151	fresh tails 0-2	8/16/96
AF01297	TL960152	fresh tails 2-4	8/16/96
AF01298	TL960153	fresh tails 4-6	8/16/96
AF01299	TL960154	plot 5A	8/16/96
AF01300	TL960155	plot 5B	8/16/96
AF01301	TL960156	plot 5C	8/16/96
AF01302	TL960157	plot 5D	8/16/96
AF01303	TL960157 - dup	Lab-QA/QC	
AF01304	blank	Lab-QA/QC	
AF01305	ref-GMT	Lab-QA/QC	
AF01306	TL960159	AT1-U	9/11/96
AF01307	TL960160	AT1-M	9/11/96
AF01308	TL960161	AT1-L	9/11/96
AF01309	TL960162	AT2-U	9/11/96
AF01310	TL960163	AT2-M	9/11/96
AF01311	TL960164	AT2-L	9/11/96
AF01312	TL960165	AT3-U	9/11/96
AF01313	TL960166	AT3-M	9/11/96
AF01314	TL960167	AT3-L	9/11/96
AF01315	TL960168	AT4-L	9/11/96
AF01316	TL960169	REF-SMI	9/11/96
AF01317	TL960170	REF-SA	9/11/96
AF01318	TL960171	AT1-U-DUP	9/11/96
AF01319	TL960172	BLANK - SMI	9/11/96
AF01320	TL960173	AT4-M	9/11/96
AF01321	TL960173 - dup	Lab-QA/QC	
AF01322	blank	Lab-QA/QC	
AF01323	ref-GMT	Lab-QA/QC	
AF01324	TL960174	AT4-U	9/11/96
AF01325	TL960175	AT5-U	9/11/96

**Table A-1 Key to KEL Sample Number, Sample Description, and SMI/SA Sample ID  
(continued)**

KEL Sample Number Number	KEL Sample Description	SMI/SA sample ID	Date Collected
AF01326	TL960176	AT5-M	9/11/96
AF01327	TL960177	AT5-L	9/11/96
AF01328	TL960178	AT14-U	9/11/96
AF01329	TL960179	AT14-M	9/11/96
AF01330	TL960180	AT14-L	9/11/96
AF01331	TL960181	AT13-U	9/11/96
AF01332	TL960182	AT13-M	9/11/96
AF01333	TL960183	REF-SMI	9/11/96
AF01334	TL960184	REF-SA	9/11/96
AF01335	TL960185	AT13-U-DUP	9/11/96
AF01336	TL960186	BLANK - SMI	9/11/96
AF01337	TL960187	AT13-L	9/11/96
AF01338	TL960188	AT12-U	9/11/96
AF01339	TL960188 - dup	Lab-QA/QC	
AF01340	blank	Lab-QA/QC	
AF01341	ref-GMT	Lab-QA/QC	
AF01342	TL960189	AT12-M	9/11/96
AF01343	TL960190	AT12-L	9/11/96
AF01344	TL960191	UE1-0-6	9/12/96
AF01345	TL960192	UE1-6-12	9/12/96
AF01346	TL960193	UE2-0-6	9/12/96
AF01347	TL960194	UE2-6-12	9/12/96
AF01348	TL960195	UE3-0-6	9/12/96
AF01349	TL960196	UE3-6-12	9/12/96
AF01350	TL960197	REF-SMI	9/12/96
AF01351	TL960198	REF-SA	9/12/96
AF01352	TL960199	AT12-M-DUP	9/12/96
AF01353	TL960200	BLANK-SMI	9/12/96
AF01354	TL960201	AT6-U	9/12/96
AF01355	TL960202	AT6-M	9/12/96
AF01356	TL960203	AT6-L	9/12/96
AF01357	TL960203 - dup	Lab-QA/QC	
AF01358	blank	Lab-QA/QC	
AF01359	ref-GMT	Lab-QA/QC	
AF01360	TL960204	AT7-U	9/12/96
AF01361	TL960205	AT7-M	9/12/96
AF01362	TL960206	AT7-L	9/12/96

**Table A-1 Key to KEL Sample Number, Sample Description, and SMI/SA Sample ID  
(continued)**

KEL Sample Number Number	KEL Sample Description	SMI/SA sample ID	Date Collected
AF01363	TL960207	AT8-U	9/12/96
AF01364	TL960208	AT8-M	9/12/96
AF01365	TL960209	AT8-L	9/12/96
AF01366	TL960210	AT9-U	9/12/96
AF01367	TL960211	REF-SMI	9/12/96
AF01368	TL960212	REF-SA	9/12/96
AF01369	TL960213	AT6-L-DUP	9/12/96
AF01370	TL960214	BLANK-SMI	9/12/96
AF01371	TL960215	AT9-M	9/12/96
AF01372	TL960216	AT9-L	9/12/96
AF01373	TL960217	AT10-U	9/12/96
AF01374	TL960218	AT10-M	9/12/96
AF01375	TL960218 - dup	Lab-QA/QC	
AF01376	blank	Lab-QA/QC	
AF01377	ref-GMT	Lab-QA/QC	
AF01378	TL960219	AT10-L	9/12/96
AF01379	TL960220	AT11-U	9/12/96
AF01380	TL960221	AT11-M	9/12/96
AF01381	TL960222	AT11-L	9/12/96
AF01382	TL960223	AT10-U-DUP	9/12/96
AF01383	TL960224	BLANK-SMI	9/12/96
AF01384	TL960225	REF-SMI	9/12/96
AF01385	TL960226	REF-SA	9/12/96
AF01386	TL960226 - dup	Lab-QA/QC	
AF01387	blank	Lab-QA/QC	
AF01388	ref-GMT	Lab-QA/QC	
AF01389	TL960227	TP4-1	9/11/96
AF01390	TL960228	TP4-4	9/11/96
AF01391	TL960229	TP4-8	9/11/96
AF01392	TL960230	TP3-1	9/11/96
AF01393	TL960231	TP3-4	9/11/96
AF01394	TL960232	TP3-8	9/11/96
AF01395	TL960233	TP2-1	9/11/96
AF01396	TL960234	TP2-4	9/11/96
AF01397	TL960235	TP2-8	9/11/96

**Table A-1 Key to KEL Sample Number, Sample Description, and SMI/SA Sample ID  
(continued)**

KEL Sample Number	KEL Sample Description	SMI/SA sample ID	Date Collected
AF01398	TL960236	TP1-1	9/11/96
AF01399	TL960237	TP1-4	9/11/96
AF01400	TL960238	TP1-8	9/11/96
AF01401	TL960239	TP2-8-DUP	9/11/96
AF01402	TL960240	REF-SMI	9/11/96
AF01403	TL960241	REF-SA	9/11/96
AF01404	TL960241 - dup	Lab-QA/QC	
AF01405	blank	Lab-QA/QC	
AF01406	ref-GMT	Lab-QA/QC	



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: MCP1484A

SAMPLE ID NUMBER: AE16865

Project: Acid/Base Accounting

COLLECTION DATE: 11/25/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-8	t CaCO <sub>3</sub> /kt
Acid Potential	38	t CaCO <sub>3</sub> /kt
Neutralization Potential	30	t CaCO <sub>3</sub> /kt
Sulfur	1.85	%
HCL Extractable Sulfur	0.03	%
HNO <sub>3</sub> Extractable Sulfur	1.21	%
Sulfur Residual	0.15	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	2840	umhos/cm
pH Paste	7.50	
Neut. Pot. as % CaCO <sub>3</sub>	3.0	%
Sulfur Acid Potential	1.21	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BCP1483A

SAMPLE ID NUMBER: AE16866

Project: Acid/Base Accounting

COLLECTION DATE: 11/25/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	25	t CaCO <sub>3</sub> /kt
Acid Potential	3	t CaCO <sub>3</sub> /kt
Neutralization Potential	28	t CaCO <sub>3</sub> /kt
Sulfur	0.24	%
HCL Extractable Sulfur	0.06	%
HNO <sub>3</sub> Extractable Sulfur	0.1	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	2780	umhos/cm
pH Paste	7.97	
Neut. Pot. as % CaCO <sub>3</sub>	2.8	%
Sulfur Acid Potential	0.10	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

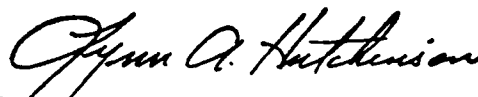
SAMPLE DESCRIPTION: MCP1484A

SAMPLE ID NUMBER: AE17511

Project: Acid/Base Accounting

COLLECTION DATE: 12/06/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-14	t CaCO <sub>3</sub> /kt
Acid Potential	47	t CaCO <sub>3</sub> /kt
Neutralization Potential	32	t CaCO <sub>3</sub> /kt
Sulfur	2.27	%
HCL Extractable Sulfur	0.08	%
HNO <sub>3</sub> Extractable Sulfur	1.91	%
Sulfur Residual	0.08	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	5000	umhos/cm
pH Paste	8.06	
Neut. Pot. as % CaCO <sub>3</sub>	3.2	%
Sulfur Acid Potential	1.91	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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Utah Copper Environmental Department

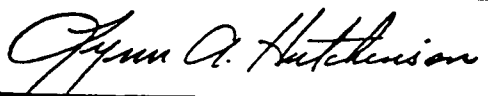
SAMPLE DESCRIPTION: BCP1483A

SAMPLE ID NUMBER: AE17512

Project: Acid/Base Accounting

COLLECTION DATE: 12/06/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	23	t CaCO <sub>3</sub> /kt
Acid Potential	9	t CaCO <sub>3</sub> /kt
Neutralization Potential	32	t CaCO <sub>3</sub> /kt
Sulfur	0.44	%
HCL Extractable Sulfur	0.08	%
HNO <sub>3</sub> Extractable Sulfur	0.30	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	4780	umhos/cm
pH Paste	8.22	
Neut. Pot. as % CaCO <sub>3</sub>	3.2	%
Sulfur Acid Potential	0.30	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department


SAMPLE DESCRIPTION: BCP1483A

SAMPLE ID NUMBER: AF00172

Project: Acid/Base Accounting

COLLECTION DATE: 10/30/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	5	t CaCO <sub>3</sub> /kt
Acid Potential	26	t CaCO <sub>3</sub> /kt
Neutralization Potential	31	t CaCO <sub>3</sub> /kt
Sulfur	1.15	%
HCL Extractable Sulfur	0.24	%
HNO <sub>3</sub> Extractable Sulfur	0.85	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	6580	umhos/cm
pH Paste	8.01	
Neut. Pot. as % CaCO <sub>3</sub>	3.1	%
Sulfur Acid Potential	0.85	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: MCP1484A

SAMPLE ID NUMBER: AF00173

Project: Acid/Base Accounting

COLLECTION DATE: 10/30/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	5	t CaCO <sub>3</sub> /kt
Acid Potential	58	t CaCO <sub>3</sub> /kt
Neutralization Potential	63	t CaCO <sub>3</sub> /kt
Sulfur	2.22	%
HCL Extractable Sulfur	0.28	%
HNO <sub>3</sub> Extractable Sulfur	1.85	%
Sulfur Residual	0.09	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	6640	umhos/cm
pH Paste	8.40	
Neut. Pot. as % CaCO <sub>3</sub>	6.3	%
Sulfur Acid Potential	1.85	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

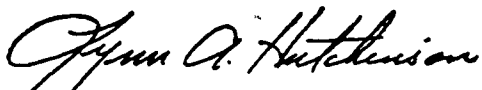
SAMPLE DESCRIPTION: SMP1481A

SAMPLE ID NUMBER: AF00174

Project: Acid/Base Accounting

COLLECTION DATE: 07/31/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	147	t CaCO <sub>3</sub> /kt
Acid Potential	2	t CaCO <sub>3</sub> /kt
Neutralization Potential	149	t CaCO <sub>3</sub> /kt
Sulfur	0.10	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.06	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	7120	umhos/cm
pH Paste	8.63	
Neut. Pot. as % CaCO <sub>3</sub>	14.9	%
Sulfur Acid Potential	0.06	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

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American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: MCP1480A

SAMPLE ID NUMBER: AF00177

Project: Acid/Base Accounting

COLLECTION DATE: 08/23/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	314	t CaCO <sub>3</sub> /kt
Acid Potential	1	t CaCO <sub>3</sub> /kt
Neutralization Potential	315	t CaCO <sub>3</sub> /kt
Sulfur	1.17	%
HCL Extractable Sulfur	1.14	%
HNO <sub>3</sub> Extractable Sulfur	0.02	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	22500	umhos/cm
pH Paste	13.06	
Neut. Pot. as % CaCO <sub>3</sub>	31.5	%
Sulfur Acid Potential	0.02	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

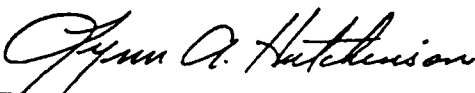
SAMPLE DESCRIPTION: TL960131

SAMPLE ID NUMBER: AF00179

Project: Acid/Base Accounting

COLLECTION DATE: 10/07/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	43	t CaCO <sub>3</sub> /kt
Acid Potential	26	t CaCO <sub>3</sub> /kt
Neutralization Potential	69	t CaCO <sub>3</sub> /kt
Sulfur	1.04	%
HCL Extractable Sulfur	0.07	%
HNO <sub>3</sub> Extractable Sulfur	0.84	%
Sulfur Residual	0.14	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	3360	umhos/cm
pH Paste	8.02	
Neut. Pot. as % CaCO <sub>3</sub>	6.9	%
Sulfur Acid Potential	0.84	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

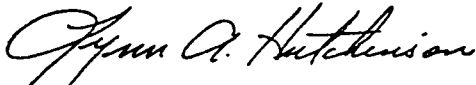
SAMPLE DESCRIPTION: BCP1483A

SAMPLE ID NUMBER: AF00180

Project: Acid/Base Accounting

COLLECTION DATE: 09/27/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	30	t CaCO <sub>3</sub> /kt
Acid Potential	7	t CaCO <sub>3</sub> /kt
Neutralization Potential	37	t CaCO <sub>3</sub> /kt
Sulfur	0.41	%
HCL Extractable Sulfur	0.17	%
HNO <sub>3</sub> Extractable Sulfur	0.22	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	6560	umhos/cm
pH Paste	7.94	
Neut. Pot. as % CaCO <sub>3</sub>	3.7	%
Sulfur Acid Potential	0.22	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: MCP1480A

SAMPLE ID NUMBER: AF00181

Project: Acid/Base Accounting

COLLECTION DATE: 04/16/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	157	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	157	t CaCO <sub>3</sub> /kt
Sulfur	0.31	%
HCL Extractable Sulfur	0.29	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	1910	umhos/cm
pH Paste	8.65	
Neut. Pot. as % CaCO <sub>3</sub>	15.7	%
Sulfur Acid Potential	NOT DETECTED	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

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Utah Copper Environmental Department

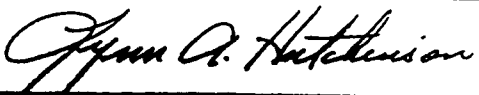
SAMPLE DESCRIPTION: BCP1483A

SAMPLE ID NUMBER: AF00183

Project: Acid/Base Accounting

COLLECTION DATE: 01/30/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	9	t CaCO <sub>3</sub> /kt
Acid Potential	10	t CaCO <sub>3</sub> /kt
Neutralization Potential	19	t CaCO <sub>3</sub> /kt
Sulfur	0.39	%
HCL Extractable Sulfur	0.05	%
HNO <sub>3</sub> Extractable Sulfur	0.32	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	1290	umhos/cm
pH Paste	8.10	
Neut. Pot. as % CaCO <sub>3</sub>	1.9	%
Sulfur Acid Potential	0.32	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

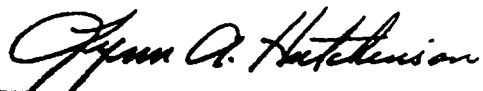
SAMPLE DESCRIPTION: BCP1483A

SAMPLE ID NUMBER: AF00186

Project: Acid/Base Accounting

COLLECTION DATE: 06/13/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	14	t CaCO <sub>3</sub> /kt
Acid Potential	19	t CaCO <sub>3</sub> /kt
Neutralization Potential	33	t CaCO <sub>3</sub> /kt
Sulfur	0.94	%
HCL Extractable Sulfur	0.31	%
HNO <sub>3</sub> Extractable Sulfur	0.61	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	1560	umhos/cm
pH Paste	8.08	
Neut. Pot. as % CaCO <sub>3</sub>	5.0	%
Sulfur Acid Potential	0.61	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BCP1483A

SAMPLE ID NUMBER: AF00187

Project: Acid/Base Accounting

COLLECTION DATE: 07/25/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	20	t CaCO <sub>3</sub> /kt
Acid Potential	2	t CaCO <sub>3</sub> /kt
Neutralization Potential	22	t CaCO <sub>3</sub> /kt
Sulfur	0.13	%
HCL Extractable Sulfur	0.08	%
HNO <sub>3</sub> Extractable Sulfur	0.05	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	410	umhos/cm
pH Paste	8.46	
Neut. Pot. as % CaCO <sub>3</sub>	2.2	%
Sulfur Acid Potential	0.05	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BCP1483A

SAMPLE ID NUMBER: AF00190

Project: Acid/Base Accounting

COLLECTION DATE: 08/21/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	29	t CaCO <sub>3</sub> /kt
Acid Potential	10	t CaCO <sub>3</sub> /kt
Neutralization Potential	39	t CaCO <sub>3</sub> /kt
Sulfur	0.37	%
HCL Extractable Sulfur	0.05	%
HNO <sub>3</sub> Extractable Sulfur	0.31	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	1600	umhos/cm
pH Paste	7.76	
Neut. Pot. as % CaCO <sub>3</sub>	3.9	%
Sulfur Acid Potential	0.31	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: MCP1484A

SAMPLE ID NUMBER: AF01268

Project: Acid/Base Accounting

COLLECTION DATE: 02/01/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-6	t CaCO <sub>3</sub> /kt
Acid Potential	32	t CaCO <sub>3</sub> /kt
Neutralization Potential	26	t CaCO <sub>3</sub> /kt
Sulfur	1.24	%
HCL Extractable Sulfur	0.10	%
HNO <sub>3</sub> Extractable Sulfur	1.04	%
Sulfur Residual	0.11	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	7940	umhos/cm
pH Paste	7.38	
Neut. Pot. as % CaCO <sub>3</sub>	2.6	%
Sulfur Acid Potential	1.04	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: MCP1484A

SAMPLE ID NUMBER: AF01269

Project: Acid/Base Accounting

COLLECTION DATE: 04/07/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-23	t CaCO <sub>3</sub> /kt
Acid Potential	64	t CaCO <sub>3</sub> /kt
Neutralization Potential	41	t CaCO <sub>3</sub> /kt
Sulfur	2.10	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	2.04	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	7010	umhos/cm
pH Paste	7.53	
Neut. Pot. as % CaCO <sub>3</sub>	4.1	%
Sulfur Acid Potential	2.04	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

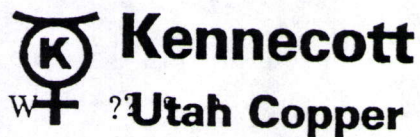
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: MCP1484A

SAMPLE ID NUMBER: AF01272

Project: Acid/Base Accounting

COLLECTION DATE: 08/20/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-24	t CaCO <sub>3</sub> /kt
Acid Potential	80	t CaCO <sub>3</sub> /kt
Neutralization Potential	56	t CaCO <sub>3</sub> /kt
Sulfur	2.66	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	2.56	%
Sulfur Residual	0.09	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	5010	umhos/cm
pH Paste	7.53	
Neut. Pot. as % CaCO <sub>3</sub>	5.6	%
Sulfur Acid Potential	2.56	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

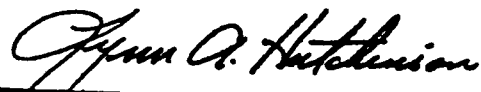
SAMPLE DESCRIPTION: MCP1484A

SAMPLE ID NUMBER: AF01273

Project: Acid/Base Accounting

COLLECTION DATE: 09/19/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-56	t CaCO <sub>3</sub> /kt
Acid Potential	77	t CaCO <sub>3</sub> /kt
Neutralization Potential	21	t CaCO <sub>3</sub> /kt
Sulfur	2.52	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	2.46	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	4830	umhos/cm
pH Paste	7.15	
Neut. Pot. as % CaCO <sub>3</sub>	2.1	%
Sulfur Acid Potential	2.46	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

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State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

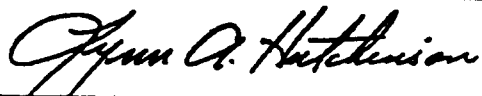
SAMPLE DESCRIPTION: TL960132

SAMPLE ID NUMBER: AF01274

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	72	t CaCO <sub>3</sub> /kt
Acid Potential	22	t CaCO <sub>3</sub> /kt
Neutralization Potential	94	t CaCO <sub>3</sub> /kt
Sulfur	1.00	%
HCL Extractable Sulfur	0.26	%
HNO <sub>3</sub> Extractable Sulfur	0.71	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	7080	umhos/cm
pH Paste	12.31	
Neut. Pot. as % CaCO <sub>3</sub>	9.4	%
Sulfur Acid Potential	0.71	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

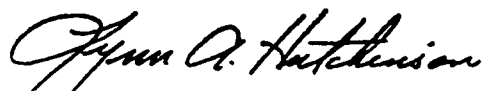
SAMPLE DESCRIPTION: TL960133

SAMPLE ID NUMBER: AF01275

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-18	t CaCO <sub>3</sub> /kt
Acid Potential	36	t CaCO <sub>3</sub> /kt
Neutralization Potential	18	t CaCO <sub>3</sub> /kt
Sulfur	1.24	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.15	%
Sulfur Residual	0.09	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	2880	umhos/cm
pH Paste	8.02	
Neut. Pot. as % CaCO <sub>3</sub>	1.8	%
Sulfur Acid Potential	1.15	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960134

SAMPLE ID NUMBER: AF01276

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	8	t CaCO <sub>3</sub> /kt
Acid Potential	10	t CaCO <sub>3</sub> /kt
Neutralization Potential	18	t CaCO <sub>3</sub> /kt
Sulfur	0.49	%
HCL Extractable Sulfur	0.14	%
HNO <sub>3</sub> Extractable Sulfur	0.32	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	2880	umhos/cm
pH Paste	7.71	
Neut. Pot. as % CaCO <sub>3</sub>	1.8	%
Sulfur Acid Potential	0.32	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960135

SAMPLE ID NUMBER: AF01277

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-12	t CaCO <sub>3</sub> /kt
Acid Potential	28	t CaCO <sub>3</sub> /kt
Neutralization Potential	16	t CaCO <sub>3</sub> /kt
Sulfur	0.95	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.91	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	1010	umhos/cm
pH Paste	7.86	
Neut. Pot. as % CaCO <sub>3</sub>	1.6	%
Sulfur Acid Potential	0.91	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960136

SAMPLE ID NUMBER: AF01278

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	100	t CaCO <sub>3</sub> /kt
Acid Potential	29	t CaCO <sub>3</sub> /kt
Neutralization Potential	129	t CaCO <sub>3</sub> /kt
Sulfur	1.10	%
HCL Extractable Sulfur	0.10	%
HNO <sub>3</sub> Extractable Sulfur	0.94	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	2870	umhos/cm
pH Paste	7.51	
Neut. Pot. as % CaCO <sub>3</sub>	12.9	%
Sulfur Acid Potential	0.94	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

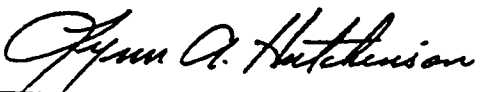
SAMPLE DESCRIPTION: TL960137

SAMPLE ID NUMBER: AF01279

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	8	t CaCO <sub>3</sub> /kt
Acid Potential	5	t CaCO <sub>3</sub> /kt
Neutralization Potential	13	t CaCO <sub>3</sub> /kt
Sulfur	0.33	%
HCL Extractable Sulfur	0.12	%
HNO <sub>3</sub> Extractable Sulfur	0.17	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	2520	umhos/cm
pH Paste	7.58	
Neut. Pot. as % CaCO <sub>3</sub>	1.3	%
Sulfur Acid Potential	0.17	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960138

SAMPLE ID NUMBER: AF01280

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-7	t CaCO <sub>3</sub> /kt
Acid Potential	23	t CaCO <sub>3</sub> /kt
Neutralization Potential	16	t CaCO <sub>3</sub> /kt
Sulfur	0.99	%
HCL Extractable Sulfur	0.20	%
HNO <sub>3</sub> Extractable Sulfur	0.73	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	3330	umhos/cm
pH Paste	7.41	
Neut. Pot. as % CaCO <sub>3</sub>	1.6	%
Sulfur Acid Potential	0.73	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960139

SAMPLE ID NUMBER: AF01281

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-1	t CaCO <sub>3</sub> /kt
Acid Potential	18	t CaCO <sub>3</sub> /kt
Neutralization Potential	17	t CaCO <sub>3</sub> /kt
Sulfur	0.73	%
HCL Extractable Sulfur	0.12	%
HNO <sub>3</sub> Extractable Sulfur	0.56	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	3010	umhos/cm
pH Paste	7.54	
Neut. Pot. as % CaCO <sub>3</sub>	1.7	%
Sulfur Acid Potential	0.56	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960140

SAMPLE ID NUMBER: AF01282

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	7	t CaCO <sub>3</sub> /kt
Acid Potential	11	t CaCO <sub>3</sub> /kt
Neutralization Potential	18	t CaCO <sub>3</sub> /kt
Sulfur	1.09	%
HCL Extractable Sulfur	0.69	%
HNO <sub>3</sub> Extractable Sulfur	0.34	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	3720	umhos/cm
pH Paste	7.72	
Neut. Pot. as % CaCO <sub>3</sub>	1.8	%
Sulfur Acid Potential	0.34	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960141

SAMPLE ID NUMBER: AF01283

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-29	t CaCO <sub>3</sub> /kt
Acid Potential	31	t CaCO <sub>3</sub> /kt
Neutralization Potential	2	t CaCO <sub>3</sub> /kt
Sulfur	1.43	%
HCL Extractable Sulfur	0.43	%
HNO <sub>3</sub> Extractable Sulfur	0.98	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	6660	umhos/cm
pH Paste	2.99	
Neut. Pot. as % CaCO <sub>3</sub>	0.2	%
Sulfur Acid Potential	0.98	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

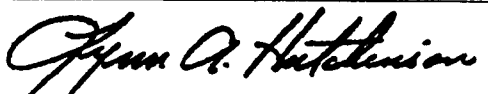
SAMPLE DESCRIPTION: TL960142

SAMPLE ID NUMBER: AF01284

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-30	t CaCO <sub>3</sub> /kt
Acid Potential	30	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	1.82	%
HCL Extractable Sulfur	0.83	%
HNO <sub>3</sub> Extractable Sulfur	0.97	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	16570	umhos/cm
pH Paste	3.03	
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	0.97	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960143

SAMPLE ID NUMBER: AF01285

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-26	t CaCO <sub>3</sub> /kt
Acid Potential	28	t CaCO <sub>3</sub> /kt
Neutralization Potential	2	t CaCO <sub>3</sub> /kt
Sulfur	3.36	%
HCL Extractable Sulfur	2.43	%
HNO <sub>3</sub> Extractable Sulfur	0.88	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	20200	umhos/cm
pH Paste	3.13	
Neut. Pot. as % CaCO <sub>3</sub>	0.2	%
Sulfur Acid Potential	0.88	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

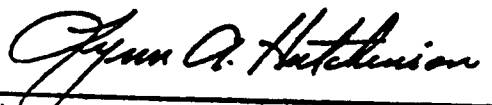
SAMPLE DESCRIPTION: TL960144

SAMPLE ID NUMBER: AF01286

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	1	t CaCO <sub>3</sub> /kt
Acid Potential	11	t CaCO <sub>3</sub> /kt
Neutralization Potential	12	t CaCO <sub>3</sub> /kt
Sulfur	1.08	%
HCL Extractable Sulfur	0.68	%
HNO <sub>3</sub> Extractable Sulfur	0.35	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	3540	umhos/cm
pH Paste	6.63	
Neut. Pot. as % CaCO <sub>3</sub>	1.2	%
Sulfur Acid Potential	0.35	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

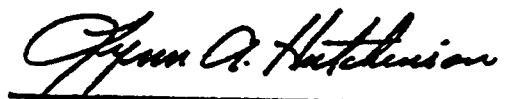
SAMPLE DESCRIPTION: TL960145

SAMPLE ID NUMBER: AF01287

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-4	t CaCO <sub>3</sub> /kt
Acid Potential	25	t CaCO <sub>3</sub> /kt
Neutralization Potential	21	t CaCO <sub>3</sub> /kt
Sulfur	0.86	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.81	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	3700	umhos/cm
pH Paste	7.31	
Neut. Pot. as % CaCO <sub>3</sub>	2.1	%
Sulfur Acid Potential	0.81	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960146

SAMPLE ID NUMBER: AF01288

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	2	t CaCO <sub>3</sub> /kt
Acid Potential	15	t CaCO <sub>3</sub> /kt
Neutralization Potential	17	t CaCO <sub>3</sub> /kt
Sulfur	0.65	%
HCL Extractable Sulfur	0.12	%
HNO <sub>3</sub> Extractable Sulfur	0.48	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	3700	umhos/cm
pH Paste	7.19	
Neut. Pot. as % CaCO <sub>3</sub>	1.7	%
Sulfur Acid Potential	0.48	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960147

SAMPLE ID NUMBER: AF01292

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	9	t CaCO <sub>3</sub> /kt
Acid Potential	11	t CaCO <sub>3</sub> /kt
Neutralization Potential	20	t CaCO <sub>3</sub> /kt
Sulfur	0.42	%
HCL Extractable Sulfur	0.05	%
HNO <sub>3</sub> Extractable Sulfur	0.35	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	4260	umhos/cm
pH Paste	7.3	
Neut. Pot. as % CaCO <sub>3</sub>	2	%
Sulfur Acid Potential	0.35	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBCK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960148

SAMPLE ID NUMBER: AF01293

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	14	t CaCO <sub>3</sub> /kt
Acid Potential	10	t CaCO <sub>3</sub> /kt
Neutralization Potential	24	t CaCO <sub>3</sub> /kt
Sulfur	0.39	%
HCL Extractable Sulfur	0.05	%
HNO <sub>3</sub> Extractable Sulfur	0.33	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	4820	umhos/cm
pH Paste	7.19	
Neut. Pot. as % CaCO <sub>3</sub>	2.4	%
Sulfur Acid Potential	0.33	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

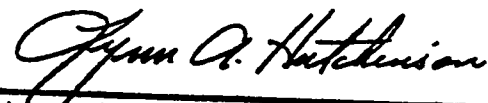
SAMPLE DESCRIPTION: TL960149

SAMPLE ID NUMBER: AF01294

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	16	t CaCO <sub>3</sub> /kt
Acid Potential	15	t CaCO <sub>3</sub> /kt
Neutralization Potential	31	t CaCO <sub>3</sub> /kt
Sulfur	0.52	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.49	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	3950	umhos/cm
pH Paste	7.33	
Neut. Pot. as % CaCO <sub>3</sub>	3.1	%
Sulfur Acid Potential	0.49	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

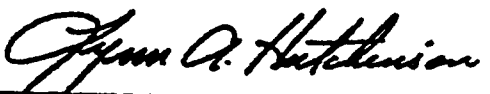
SAMPLE DESCRIPTION: TL960150

SAMPLE ID NUMBER: AF01295

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	20	t CaCO <sub>3</sub> /kt
Acid Potential	9	t CaCO <sub>3</sub> /kt
Neutralization Potential	29	t CaCO <sub>3</sub> /kt
Sulfur	0.40	%
HCL Extractable Sulfur	0.09	%
HNO <sub>3</sub> Extractable Sulfur	0.30	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	2610	umhos/cm
pH Paste	6.79	
Neut. Pot. as % CaCO <sub>3</sub>	2.9	%
Sulfur Acid Potential	0.30	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960151

SAMPLE ID NUMBER: AF01296

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	17	t CaCO <sub>3</sub> /kt
Acid Potential	15	t CaCO <sub>3</sub> /kt
Neutralization Potential	32	t CaCO <sub>3</sub> /kt
Sulfur	0.63	%
HCL Extractable Sulfur	0.10	%
HNO <sub>3</sub> Extractable Sulfur	0.49	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	6130	umhos/cm
pH Paste	7.34	
Neut. Pot. as % CaCO <sub>3</sub>	3.2	%
Sulfur Acid Potential	0.49	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

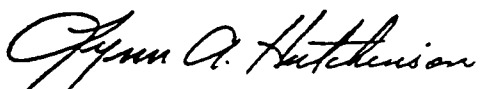
SAMPLE DESCRIPTION: TL960152

SAMPLE ID NUMBER: AF01297

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	5	t CaCO <sub>3</sub> /kt
Acid Potential	21	t CaCO <sub>3</sub> /kt
Neutralization Potential	26	t CaCO <sub>3</sub> /kt
Sulfur	0.74	%
HCL Extractable Sulfur	0.02	%
HNO <sub>3</sub> Extractable Sulfur	0.66	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	5180	umhos/cm
pH Paste	7.28	
Neut. Pot. as % CaCO <sub>3</sub>	2.6	%
Sulfur Acid Potential	0.66	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department


SAMPLE DESCRIPTION: TL960153

SAMPLE ID NUMBER: AF01298

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-2	t CaCO <sub>3</sub> /kt
Acid Potential	17	t CaCO <sub>3</sub> /kt
Neutralization Potential	15	t CaCO <sub>3</sub> /kt
Sulfur	0.61	%
HCL Extractable Sulfur	0.03	%
HNO <sub>3</sub> Extractable Sulfur	0.55	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	7900	umhos/cm
pH Paste	7.36	
Neut. Pot. as % CaCO <sub>3</sub>	1.5	%
Sulfur Acid Potential	0.55	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960154

SAMPLE ID NUMBER: AF01299

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	5	t CaCO <sub>3</sub> /kt
Acid Potential	22	t CaCO <sub>3</sub> /kt
Neutralization Potential	27	t CaCO <sub>3</sub> /kt
Sulfur	0.76	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.71	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.7	%
Sulfur Acid Potential	0.71	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960155

SAMPLE ID NUMBER: AF01300

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-13	t CaCO <sub>3</sub> /kt
Acid Potential	37	t CaCO <sub>3</sub> /kt
Neutralization Potential	24	t CaCO <sub>3</sub> /kt
Sulfur	1.23	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.19	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.4	%
Sulfur Acid Potential	1.19	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121

**CERTIFICATE OF ANALYSIS**

**05/14/97**

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

**SAMPLE DESCRIPTION: TL960156**

**SAMPLE ID NUMBER: AF01301**

**Project: Acid/Base Accounting**

**COLLECTION DATE: 10/09/96**

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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Environmental Laboratory  
9600 West 2100 South  
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(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

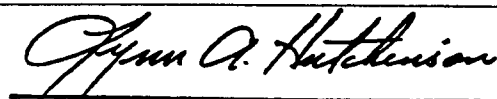
SAMPLE DESCRIPTION: TL960157

SAMPLE ID NUMBER: AF01302

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	56	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	62	t CaCO <sub>3</sub> /kt
Sulfur	0.32	%
HCL Extractable Sulfur	0.02	%
HNO <sub>3</sub> Extractable Sulfur	0.18	%
Sulfur Residual	0.12	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	6.2	%
Sulfur Acid Potential	0.18	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960159

SAMPLE ID NUMBER: AF01306

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	8	t CaCO <sub>3</sub> /kt
Acid Potential	3	t CaCO <sub>3</sub> /kt
Neutralization Potential	11	t CaCO <sub>3</sub> /kt
Sulfur	1.66	%
HCL Extractable Sulfur	1.38	%
HNO <sub>3</sub> Extractable Sulfur	0.17	%
Sulfur Residual	0.17	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.1	%
Sulfur Acid Potential	0.11	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960160

SAMPLE ID NUMBER: AF01307

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	10	t CaCO <sub>3</sub> /kt
Acid Potential	35	t CaCO <sub>3</sub> /kt
Neutralization Potential	45	t CaCO <sub>3</sub> /kt
Sulfur	1.70	%
HCL Extractable Sulfur	0.52	%
HNO <sub>3</sub> Extractable Sulfur	1.11	%
Sulfur Residual	0.07	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	4.5	%
Sulfur Acid Potential	1.11	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

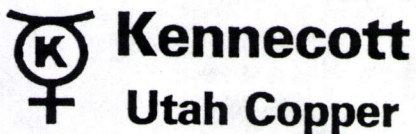
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960161

SAMPLE ID NUMBER: AF01308

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-11	t CaCO <sub>3</sub> /kt
Acid Potential	11	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	0.89	%
HCL Extractable Sulfur	0.54	%
HNO <sub>3</sub> Extractable Sulfur	0.34	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	0.34	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

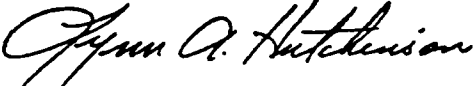
SAMPLE DESCRIPTION: TL960162

SAMPLE ID NUMBER: AF01309

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-26	t CaCO <sub>3</sub> /kt
Acid Potential	37	t CaCO <sub>3</sub> /kt
Neutralization Potential	11	t CaCO <sub>3</sub> /kt
Sulfur	1.21	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.18	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.1	%
Sulfur Acid Potential	1.18	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

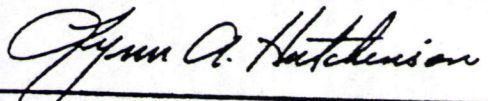
SAMPLE DESCRIPTION: TL960163

SAMPLE ID NUMBER: AF01310

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-16	t CaCO <sub>3</sub> /kt
Acid Potential	16	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	1.20	%
HCL Extractable Sulfur	0.67	%
HNO <sub>3</sub> Extractable Sulfur	0.51	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	0.51	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

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State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960164

SAMPLE ID NUMBER: AF01311

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	81	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	87	t CaCO <sub>3</sub> /kt
Sulfur	0.76	%
HCL Extractable Sulfur	0.56	%
HNO <sub>3</sub> Extractable Sulfur	0.19	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	8.7	%
Sulfur Acid Potential	0.19	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

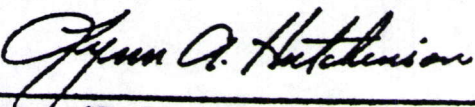
SAMPLE DESCRIPTION: TL960165

SAMPLE ID NUMBER: AF01312

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-2	t CaCO <sub>3</sub> /kt
Acid Potential	9	t CaCO <sub>3</sub> /kt
Neutralization Potential	7	t CaCO <sub>3</sub> /kt
Sulfur	0.42	%
HCL Extractable Sulfur	0.07	%
HNO <sub>3</sub> Extractable Sulfur	0.28	%
Sulfur Residual	0.07	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	0.7	%
Sulfur Acid Potential	0.28	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960166

SAMPLE ID NUMBER: AF01313

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-15	t CaCO <sub>3</sub> /kt
Acid Potential	54	t CaCO <sub>3</sub> /kt
Neutralization Potential	39	t CaCO <sub>3</sub> /kt
Sulfur	1.81	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.74	%
Sulfur Residual	0.07	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	3.9	%
Sulfur Acid Potential	1.74	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960167

SAMPLE ID NUMBER: AF01314

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-9	t CaCO <sub>3</sub> /kt
Acid Potential	13	t CaCO <sub>3</sub> /kt
Neutralization Potential	4	t CaCO <sub>3</sub> /kt
Sulfur	1.24	%
HCL Extractable Sulfur	0.77	%
HNO <sub>3</sub> Extractable Sulfur	0.43	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	0.4	%
Sulfur Acid Potential	0.43	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960168

SAMPLE ID NUMBER: AF01315

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-15	t CaCO <sub>3</sub> /kt
Acid Potential	25	t CaCO <sub>3</sub> /kt
Neutralization Potential	10	t CaCO <sub>3</sub> /kt
Sulfur	0.81	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.80	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1	%
Sulfur Acid Potential	0.80	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960169

SAMPLE ID NUMBER: AF01316

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	9	t CaCO <sub>3</sub> /kt
Acid Potential	15	t CaCO <sub>3</sub> /kt
Neutralization Potential	24	t CaCO <sub>3</sub> /kt
Sulfur	0.51	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.47	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.4	%
Sulfur Acid Potential	0.47	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960170

SAMPLE ID NUMBER: AF01317

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	55	t CaCO <sub>3</sub> /kt
Acid Potential	7	t CaCO <sub>3</sub> /kt
Neutralization Potential	62	t CaCO <sub>3</sub> /kt
Sulfur	0.32	%
HCL Extractable Sulfur	0.01	%
HNO <sub>3</sub> Extractable Sulfur	0.23	%
Sulfur Residual	0.07	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	6.2	%
Sulfur Acid Potential	0.23	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121

**CERTIFICATE OF ANALYSIS**

**05/14/97**

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

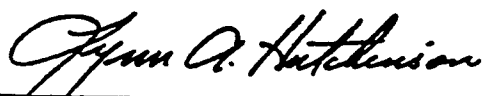
SAMPLE DESCRIPTION: TL960171

SAMPLE ID NUMBER: AF01318

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-48	t CaCO <sub>3</sub> /kt
Acid Potential	63	t CaCO <sub>3</sub> /kt
Neutralization Potential	15	t CaCO <sub>3</sub> /kt
Sulfur	2.49	%
HCL Extractable Sulfur	0.39	%
HNO <sub>3</sub> Extractable Sulfur	2.03	%
Sulfur Residual	0.07	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.5	%
Sulfur Acid Potential	2.03	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960172

SAMPLE ID NUMBER: AF01319

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960173

SAMPLE ID NUMBER: AF01320

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-11	t CaCO3/kt
Acid Potential	46	t CaCO3/kt
Neutralization Potential	35	t CaCO3/kt
Sulfur	1.60	%
HCL Extractable Sulfur	0.11	%
HNO3 Extractable Sulfur	1.46	%
Sulfur Residual	0.03	%
Moisture %H2O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO3	3.5	%
Sulfur Acid Potential	1.46	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO3 Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960174

SAMPLE ID NUMBER: AF01324

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	8	t CaCO <sub>3</sub> /kt
Acid Potential	22	t CaCO <sub>3</sub> /kt
Neutralization Potential	30	t CaCO <sub>3</sub> /kt
Sulfur	1.13	%
HCL Extractable Sulfur	0.40	%
HNO <sub>3</sub> Extractable Sulfur	0.69	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	3	%
Sulfur Acid Potential	0.69	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960175

SAMPLE ID NUMBER: AF01325

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-12	t CaCO <sub>3</sub> /kt
Acid Potential	47	t CaCO <sub>3</sub> /kt
Neutralization Potential	35	t CaCO <sub>3</sub> /kt
Sulfur	1.74	%
HCL Extractable Sulfur	0.15	%
HNO <sub>3</sub> Extractable Sulfur	1.51	%
Sulfur Residual	0.08	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity	Not Analyzed	umhos/cm
pH Paste	Not Analyzed	
Neut. Pot. as % CaCO <sub>3</sub>	3.5	%
Sulfur Acid Potential	1.51	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960176

SAMPLE ID NUMBER: AF01326

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-7	t CaCO <sub>3</sub> /kt
Acid Potential	9	t CaCO <sub>3</sub> /kt
Neutralization Potential	2	t CaCO <sub>3</sub> /kt
Sulfur	0.98	%
HCL Extractable Sulfur	0.67	%
HNO <sub>3</sub> Extractable Sulfur	0.28	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	0.2	%
Sulfur Acid Potential	0.28	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960177

SAMPLE ID NUMBER: AF01327

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	4	t CaCO3/kt
Acid Potential	3	t CaCO3/kt
Neutralization Potential	7	t CaCO3/kt
Sulfur	0.51	%
HCL Extractable Sulfur	0.42	%
HNO3 Extractable Sulfur	0.08	%
Sulfur Residual	NOT DETECTED	%
Moisture %H2O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO3	0.7	%
Sulfur Acid Potential	0.08	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO3 Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

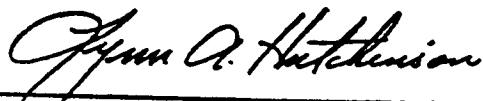
SAMPLE DESCRIPTION: TL960178

SAMPLE ID NUMBER: AF01328

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-18	t CaCO <sub>3</sub> /kt
Acid Potential	54	t CaCO <sub>3</sub> /kt
Neutralization Potential	36	t CaCO <sub>3</sub> /kt
Sulfur	1.85	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.74	%
Sulfur Residual	0.10	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	3.6	%
Sulfur Acid Potential	1.74	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960179

SAMPLE ID NUMBER: AF01329

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-39	t CaCO <sub>3</sub> /kt
Acid Potential	49	t CaCO <sub>3</sub> /kt
Neutralization Potential	10	t CaCO <sub>3</sub> /kt
Sulfur	1.68	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.57	%
Sulfur Residual	0.10	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1	%
Sulfur Acid Potential	1.57	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960180

SAMPLE ID NUMBER: AF01330

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-51	t CaCO <sub>3</sub> /kt
Acid Potential	51	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	2.15	%
HCL Extractable Sulfur	0.50	%
HNO <sub>3</sub> Extractable Sulfur	1.62	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	1.62	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEX

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960181

SAMPLE ID NUMBER: AF01331

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	14	t CaCO <sub>3</sub> /kt
Acid Potential	8	t CaCO <sub>3</sub> /kt
Neutralization Potential	22	t CaCO <sub>3</sub> /kt
Sulfur	0.78	%
HCL Extractable Sulfur	0.48	%
HNO <sub>3</sub> Extractable Sulfur	0.26	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.2	%
Sulfur Acid Potential	0.26	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960182

SAMPLE ID NUMBER: AF01332

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-50	t CaCO <sub>3</sub> /kt
Acid Potential	70	t CaCO <sub>3</sub> /kt
Neutralization Potential	20	t CaCO <sub>3</sub> /kt
Sulfur	2.35	%
HCL Extractable Sulfur	2.04	%
HNO <sub>3</sub> Extractable Sulfur	2.23	%
Sulfur Residual	0.11	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2	%
Sulfur Acid Potential	2.23	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960183

SAMPLE ID NUMBER: AF01333

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	14	t CaCO <sub>3</sub> /kt
Acid Potential	12	t CaCO <sub>3</sub> /kt
Neutralization Potential	26	t CaCO <sub>3</sub> /kt
Sulfur	0.59	%
HCL Extractable Sulfur	0.16	%
HNO <sub>3</sub> Extractable Sulfur	0.38	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.6	%
Sulfur Acid Potential	0.38	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960184

SAMPLE ID NUMBER: AF01334

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	66	t CaCO <sub>3</sub> /kt
Acid Potential	5	t CaCO <sub>3</sub> /kt
Neutralization Potential	71	t CaCO <sub>3</sub> /kt
Sulfur	0.32	%
HCL Extractable Sulfur	0.05	%
HNO <sub>3</sub> Extractable Sulfur	0.15	%
Sulfur Residual	0.13	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	7.1	%
Sulfur Acid Potential	0.15	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department


SAMPLE DESCRIPTION: TL960185

SAMPLE ID NUMBER: AF01335

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	9	t CaCO <sub>3</sub> /kt
Acid Potential	16	t CaCO <sub>3</sub> /kt
Neutralization Potential	25	t CaCO <sub>3</sub> /kt
Sulfur	0.76	%
HCL Extractable Sulfur	0.21	%
HNO <sub>3</sub> Extractable Sulfur	0.52	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.5	%
Sulfur Acid Potential	0.52	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960186

SAMPLE ID NUMBER: AF01336

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121

**CERTIFICATE OF ANALYSIS**

**05/14/97**

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960187

SAMPLE ID NUMBER: AF01337

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-72	t CaCO <sub>3</sub> /kt
Acid Potential	94	t CaCO <sub>3</sub> /kt
Neutralization Potential	22	t CaCO <sub>3</sub> /kt
Sulfur	3.66	%
HCL Extractable Sulfur	0.39	%
HNO <sub>3</sub> Extractable Sulfur	3.02	%
Sulfur Residual	0.24	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.2	%
Sulfur Acid Potential	3.02	%



Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960188

SAMPLE ID NUMBER: AF01338

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-19	t CaCO <sub>3</sub> /kt
Acid Potential	38	t CaCO <sub>3</sub> /kt
Neutralization Potential	19	t CaCO <sub>3</sub> /kt
Sulfur	1.29	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.23	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.9	%
Sulfur Acid Potential	1.23	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960189

SAMPLE ID NUMBER: AF01342

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-9	t CaCO <sub>3</sub> /kt
Acid Potential	23	t CaCO <sub>3</sub> /kt
Neutralization Potential	14	t CaCO <sub>3</sub> /kt
Sulfur	0.82	%
HCL Extractable Sulfur	0.05	%
HNO <sub>3</sub> Extractable Sulfur	0.73	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.4	%
Sulfur Acid Potential	0.73	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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Environmental Laboratory  
9600 West 2100 South  
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(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960190

SAMPLE ID NUMBER: AF01343

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-8	t CaCO <sub>3</sub> /kt
Acid Potential	13	t CaCO <sub>3</sub> /kt
Neutralization Potential	5	t CaCO <sub>3</sub> /kt
Sulfur	0.96	%
HCL Extractable Sulfur	0.54	%
HNO <sub>3</sub> Extractable Sulfur	0.41	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	0.5	%
Sulfur Acid Potential	0.41	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960191

SAMPLE ID NUMBER: AF01344

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-15	t CaCO <sub>3</sub> /kt
Acid Potential	43	t CaCO <sub>3</sub> /kt
Neutralization Potential	28	t CaCO <sub>3</sub> /kt
Sulfur	1.46	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.38	%
Sulfur Residual	0.08	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.8	%
Sulfur Acid Potential	1.38	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960192

SAMPLE ID NUMBER: AF01345

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-17	t CaCO <sub>3</sub> /kt
Acid Potential	42	t CaCO <sub>3</sub> /kt
Neutralization Potential	25	t CaCO <sub>3</sub> /kt
Sulfur	1.41	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.35	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.5	%
Sulfur Acid Potential	1.35	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960193

SAMPLE ID NUMBER: AF01346

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-8	t CaCO <sub>3</sub> /kt
Acid Potential	34	t CaCO <sub>3</sub> /kt
Neutralization Potential	26	t CaCO <sub>3</sub> /kt
Sulfur	1.22	%
HCL Extractable Sulfur	0.06	%
HNO <sub>3</sub> Extractable Sulfur	1.10	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.6	%
Sulfur Acid Potential	1.10	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960194

SAMPLE ID NUMBER: AF01347

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	2	t CaCO <sub>3</sub> /kt
Acid Potential	37	t CaCO <sub>3</sub> /kt
Neutralization Potential	39	t CaCO <sub>3</sub> /kt
Sulfur	1.37	%
HCL Extractable Sulfur	0.14	%
HNO <sub>3</sub> Extractable Sulfur	1.17	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	3.9	%
Sulfur Acid Potential	1.17	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960195

SAMPLE ID NUMBER: AF01348

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-16	t CaCO <sub>3</sub> /kt
Acid Potential	43	t CaCO <sub>3</sub> /kt
Neutralization Potential	27	t CaCO <sub>3</sub> /kt
Sulfur	1.45	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.39	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.7	%
Sulfur Acid Potential	1.39	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960196

SAMPLE ID NUMBER: AF01349

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-2	t CaCO3/kt
Acid Potential	36	t CaCO3/kt
Neutralization Potential	34	t CaCO3/kt
Sulfur	1.53	%
HCL Extractable Sulfur	0.35	%
HNO3 Extractable Sulfur	1.14	%
Sulfur Residual	0.05	%
Moisture %H2O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO3	3.4	%
Sulfur Acid Potential	1.14	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO3 Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960197

SAMPLE ID NUMBER: AF01350

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	14	t CaCO <sub>3</sub> /kt
Acid Potential	12	t CaCO <sub>3</sub> /kt
Neutralization Potential	26	t CaCO <sub>3</sub> /kt
Sulfur	0.70	%
HCL Extractable Sulfur	0.28	%
HNO <sub>3</sub> Extractable Sulfur	0.38	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.6	%
Sulfur Acid Potential	0.38	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960198

SAMPLE ID NUMBER: AF01351

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	53	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	59	t CaCO <sub>3</sub> /kt
Sulfur	0.31	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.20	%
Sulfur Residual	0.11	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	5.9	%
Sulfur Acid Potential	0.20	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960199

SAMPLE ID NUMBER: AF01352

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	0	t CaCO <sub>3</sub> /kt
Acid Potential	24	t CaCO <sub>3</sub> /kt
Neutralization Potential	24	t CaCO <sub>3</sub> /kt
Sulfur	0.82	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.78	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.4	%
Sulfur Acid Potential	0.78	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960200

SAMPLE ID NUMBER: AF01353

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960201

SAMPLE ID NUMBER: AF01354

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-1	t CaCO <sub>3</sub> /kt
Acid Potential	26	t CaCO <sub>3</sub> /kt
Neutralization Potential	25	t CaCO <sub>3</sub> /kt
Sulfur	1.16	%
HCL Extractable Sulfur	0.28	%
HNO <sub>3</sub> Extractable Sulfur	0.82	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.5	%
Sulfur Acid Potential	0.82	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960202

SAMPLE ID NUMBER: AF01355

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-8	t CaCO <sub>3</sub> /kt
Acid Potential	8	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	0.66	%
HCL Extractable Sulfur	0.36	%
HNO <sub>3</sub> Extractable Sulfur	0.26	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	0.26	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960203

SAMPLE ID NUMBER: AF01356

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	5	t CaCO <sub>3</sub> /kt
Acid Potential	7	t CaCO <sub>3</sub> /kt
Neutralization Potential	12	t CaCO <sub>3</sub> /kt
Sulfur	1.10	%
HCL Extractable Sulfur	0.84	%
HNO <sub>3</sub> Extractable Sulfur	0.21	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.2	%
Sulfur Acid Potential	0.21	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

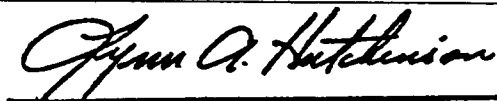
SAMPLE DESCRIPTION: TL960204

SAMPLE ID NUMBER: AF01360

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-5	t CaCO <sub>3</sub> /kt
Acid Potential	24	t CaCO <sub>3</sub> /kt
Neutralization Potential	19	t CaCO <sub>3</sub> /kt
Sulfur	0.80	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.76	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.9	%
Sulfur Acid Potential	0.76	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

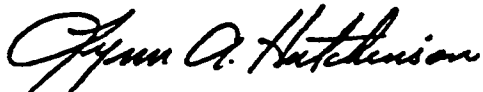
SAMPLE DESCRIPTION: TL960205

SAMPLE ID NUMBER: AF01361

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-25	t CaCO <sub>3</sub> /kt
Acid Potential	27	t CaCO <sub>3</sub> /kt
Neutralization Potential	2	t CaCO <sub>3</sub> /kt
Sulfur	1.83	%
HCL Extractable Sulfur	0.93	%
HNO <sub>3</sub> Extractable Sulfur	0.85	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	0.2	%
Sulfur Acid Potential	0.85	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

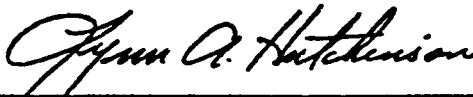
SAMPLE DESCRIPTION: TL960206

SAMPLE ID NUMBER: AF01362

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	58	t CaCO <sub>3</sub> /kt
Acid Potential	7	t CaCO <sub>3</sub> /kt
Neutralization Potential	65	t CaCO <sub>3</sub> /kt
Sulfur	0.76	%
HCL Extractable Sulfur	0.52	%
HNO <sub>3</sub> Extractable Sulfur	0.22	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	6.5	%
Sulfur Acid Potential	0.22	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960207

SAMPLE ID NUMBER: AF01363

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-5	t CaCO <sub>3</sub> /kt
Acid Potential	33	t CaCO <sub>3</sub> /kt
Neutralization Potential	28	t CaCO <sub>3</sub> /kt
Sulfur	1.20	%
HCL Extractable Sulfur	0.10	%
HNO <sub>3</sub> Extractable Sulfur	1.04	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.8	%
Sulfur Acid Potential	1.04	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960208

SAMPLE ID NUMBER: AF01364

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-5	t CaCO <sub>3</sub> /kt
Acid Potential	5	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	0.66	%
HCL Extractable Sulfur	0.46	%
HNO <sub>3</sub> Extractable Sulfur	0.16	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	0.16	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department


SAMPLE DESCRIPTION: TL960209

SAMPLE ID NUMBER: AF01365

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-17	t CaCO <sub>3</sub> /kt
Acid Potential	33	t CaCO <sub>3</sub> /kt
Neutralization Potential	16	t CaCO <sub>3</sub> /kt
Sulfur	2.08	%
HCL Extractable Sulfur	0.99	%
HNO <sub>3</sub> Extractable Sulfur	1.04	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.6	%
Sulfur Acid Potential	1.04	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department


SAMPLE DESCRIPTION: TL960210

SAMPLE ID NUMBER: AF01366

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	8	t CaCO <sub>3</sub> /kt
Acid Potential	12	t CaCO <sub>3</sub> /kt
Neutralization Potential	20	t CaCO <sub>3</sub> /kt
Sulfur	0.64	%
HCL Extractable Sulfur	0.22	%
HNO <sub>3</sub> Extractable Sulfur	0.39	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2	%
Sulfur Acid Potential	0.39	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960211

SAMPLE ID NUMBER: AF01367

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	5	t CaCO <sub>3</sub> /kt
Acid Potential	19	t CaCO <sub>3</sub> /kt
Neutralization Potential	24	t CaCO <sub>3</sub> /kt
Sulfur	0.65	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.60	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.4	%
Sulfur Acid Potential	0.60	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

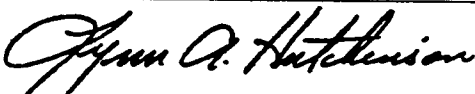
SAMPLE DESCRIPTION: TL960212

SAMPLE ID NUMBER: AF01368

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT ANALYZED	t CaCO <sub>3</sub> /kt
Acid Potential	INSUFFCNT SMPL	t CaCO <sub>3</sub> /kt
Neutralization Potential	70	t CaCO <sub>3</sub> /kt
Sulfur	0.30	%
HCL Extractable Sulfur	INSUFFCNT SMPL	%
HNO <sub>3</sub> Extractable Sulfur	INSUFFCNT SMPL	%
Sulfur Residual	INSUFFCNT SMPL	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	7	%
Sulfur Acid Potential	INSUFFCNT SMPL	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960213

SAMPLE ID NUMBER: AF01369

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-2	t CaCO <sub>3</sub> /kt
Acid Potential	17	t CaCO <sub>3</sub> /kt
Neutralization Potential	15	t CaCO <sub>3</sub> /kt
Sulfur	0.61	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.55	%
Sulfur Residual	0.07	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.5	%
Sulfur Acid Potential	0.55	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960214

SAMPLE ID NUMBER: AF01370

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960215

SAMPLE ID NUMBER: AF01371

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	1	t CaCO <sub>3</sub> /kt
Acid Potential	44	t CaCO <sub>3</sub> /kt
Neutralization Potential	45	t CaCO <sub>3</sub> /kt
Sulfur	1.47	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.42	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	4.5	%
Sulfur Acid Potential	1.42	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960216

SAMPLE ID NUMBER: AF01372

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-3	t CaCO <sub>3</sub> /kt
Acid Potential	17	t CaCO <sub>3</sub> /kt
Neutralization Potential	14	t CaCO <sub>3</sub> /kt
Sulfur	0.80	%
HCL Extractable Sulfur	0.20	%
HNO <sub>3</sub> Extractable Sulfur	0.54	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.4	%
Sulfur Acid Potential	0.54	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960217

SAMPLE ID NUMBER: AF01373

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	13	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	19	t CaCO <sub>3</sub> /kt
Sulfur	0.60	%
HCL Extractable Sulfur	0.37	%
HNO <sub>3</sub> Extractable Sulfur	0.19	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.9	%
Sulfur Acid Potential	0.19	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960218

SAMPLE ID NUMBER: AF01374

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-17	t CaCO <sub>3</sub> /kt
Acid Potential	33	t CaCO <sub>3</sub> /kt
Neutralization Potential	16	t CaCO <sub>3</sub> /kt
Sulfur	1.90	%
HCL Extractable Sulfur	0.81	%
HNO <sub>3</sub> Extractable Sulfur	1.04	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.6	%
Sulfur Acid Potential	1.04	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

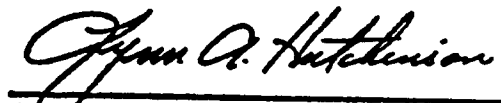
SAMPLE DESCRIPTION: TL960219

SAMPLE ID NUMBER: AF01378

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-17	t CaCO <sub>3</sub> /kt
Acid Potential	28	t CaCO <sub>3</sub> /kt
Neutralization Potential	11	t CaCO <sub>3</sub> /kt
Sulfur	1.40	%
HCL Extractable Sulfur	0.46	%
HNO <sub>3</sub> Extractable Sulfur	0.90	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.1	%
Sulfur Acid Potential	0.90	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

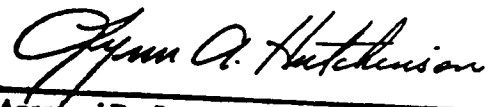
SAMPLE DESCRIPTION: TL960220

SAMPLE ID NUMBER: AF01379

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-10	t CaCO <sub>3</sub> /kt
Acid Potential	26	t CaCO <sub>3</sub> /kt
Neutralization Potential	16	t CaCO <sub>3</sub> /kt
Sulfur	0.95	%
HCL Extractable Sulfur	0.06	%
HNO <sub>3</sub> Extractable Sulfur	0.83	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.6	%
Sulfur Acid Potential	0.83	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960221

SAMPLE ID NUMBER: AF01380

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-2	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	4	t CaCO <sub>3</sub> /kt
Sulfur	0.97	%
HCL Extractable Sulfur	0.75	%
HNO <sub>3</sub> Extractable Sulfur	0.20	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	0.4	%
Sulfur Acid Potential	0.20	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department


SAMPLE DESCRIPTION: TL960222

SAMPLE ID NUMBER: AF01381

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-6	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	0.71	%
HCL Extractable Sulfur	0.51	%
HNO <sub>3</sub> Extractable Sulfur	0.19	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	0.19	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

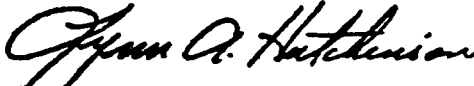
SAMPLE DESCRIPTION: TL960223

SAMPLE ID NUMBER: AF01382

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	3	t CaCO <sub>3</sub> /kt
Acid Potential	18	t CaCO <sub>3</sub> /kt
Neutralization Potential	21	t CaCO <sub>3</sub> /kt
Sulfur	0.61	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.56	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.1	%
Sulfur Acid Potential	0.56	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960224

SAMPLE ID NUMBER: AF01383

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	<0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

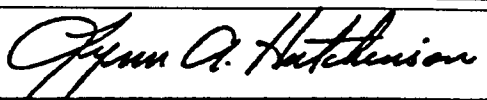
SAMPLE DESCRIPTION: TL960225

SAMPLE ID NUMBER: AF01384

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	16	t CaCO <sub>3</sub> /kt
Acid Potential	13	t CaCO <sub>3</sub> /kt
Neutralization Potential	29	t CaCO <sub>3</sub> /kt
Sulfur	0.81	%
HCL Extractable Sulfur	0.34	%
HNO <sub>3</sub> Extractable Sulfur	0.43	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.9	%
Sulfur Acid Potential	0.43	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

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State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960226

SAMPLE ID NUMBER: AF01385

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT ANALYZED	t CaCO <sub>3</sub> /kt
Acid Potential	INSUFFCNT SMPL	t CaCO <sub>3</sub> /kt
Neutralization Potential	65	t CaCO <sub>3</sub> /kt
Sulfur	0.57	%
HCL Extractable Sulfur	INSUFFCNT SMPL	%
HNO <sub>3</sub> Extractable Sulfur	INSUFFCNT SMPL	%
Sulfur Residual	INSUFFCNT SMPL	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	6.5	%
Sulfur Acid Potential	INSUFFCNT SMPL	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960227

SAMPLE ID NUMBER: AF01389

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	3	t CaCO <sub>3</sub> /kt
Acid Potential	13	t CaCO <sub>3</sub> /kt
Neutralization Potential	16	t CaCO <sub>3</sub> /kt
Sulfur	0.77	%
HCL Extractable Sulfur	0.32	%
HNO <sub>3</sub> Extractable Sulfur	0.43	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.6	%
Sulfur Acid Potential	0.43	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960228

SAMPLE ID NUMBER: AF01390

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-3	t CaCO <sub>3</sub> /kt
Acid Potential	21	t CaCO <sub>3</sub> /kt
Neutralization Potential	18	t CaCO <sub>3</sub> /kt
Sulfur	0.71	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.68	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.8	%
Sulfur Acid Potential	0.68	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

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American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department


SAMPLE DESCRIPTION: TL960229

SAMPLE ID NUMBER: AF01391

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	13	t CaCO <sub>3</sub> /kt
Acid Potential	11	t CaCO <sub>3</sub> /kt
Neutralization Potential	24	t CaCO <sub>3</sub> /kt
Sulfur	0.46	%
HCL Extractable Sulfur	0.10	%
HNO <sub>3</sub> Extractable Sulfur	0.34	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.4	%
Sulfur Acid Potential	0.34	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960230

SAMPLE ID NUMBER: AF01392

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	32	t CaCO <sub>3</sub> /kt
Acid Potential	15	t CaCO <sub>3</sub> /kt
Neutralization Potential	47	t CaCO <sub>3</sub> /kt
Sulfur	0.68	%
HCL Extractable Sulfur	0.18	%
HNO <sub>3</sub> Extractable Sulfur	0.49	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	4.7	%
Sulfur Acid Potential	0.49	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

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State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960231

SAMPLE ID NUMBER: AF01393

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-5	t CaCO <sub>3</sub> /kt
Acid Potential	23	t CaCO <sub>3</sub> /kt
Neutralization Potential	18	t CaCO <sub>3</sub> /kt
Sulfur	0.78	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.73	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.8	%
Sulfur Acid Potential	0.73	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

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State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960232

SAMPLE ID NUMBER: AF01394

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-6	t CaCO <sub>3</sub> /kt
Acid Potential	35	t CaCO <sub>3</sub> /kt
Neutralization Potential	29	t CaCO <sub>3</sub> /kt
Sulfur	1.16	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.11	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.9	%
Sulfur Acid Potential	1.11	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960233

SAMPLE ID NUMBER: AF01395

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	6	t CaCO <sub>3</sub> /kt
Acid Potential	14	t CaCO <sub>3</sub> /kt
Neutralization Potential	20	t CaCO <sub>3</sub> /kt
Sulfur	0.50	%
HCL Extractable Sulfur	0.03	%
HNO <sub>3</sub> Extractable Sulfur	0.44	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2	%
Sulfur Acid Potential	0.44	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960234

SAMPLE ID NUMBER: AF01396

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-35	t CaCO <sub>3</sub> /kt
Acid Potential	59	t CaCO <sub>3</sub> /kt
Neutralization Potential	24	t CaCO <sub>3</sub> /kt
Sulfur	1.94	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.89	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.4	%
Sulfur Acid Potential	1.89	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960235

SAMPLE ID NUMBER: AF01397

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	4	t CaCO <sub>3</sub> /kt
Acid Potential	7	t CaCO <sub>3</sub> /kt
Neutralization Potential	11	t CaCO <sub>3</sub> /kt
Sulfur	0.29	%
HCL Extractable Sulfur	0.04	%
HNO <sub>3</sub> Extractable Sulfur	0.21	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.1	%
Sulfur Acid Potential	0.21	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

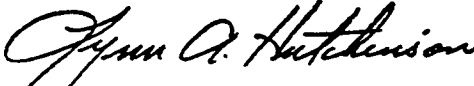
SAMPLE DESCRIPTION: TL960236

SAMPLE ID NUMBER: AF01398

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-15	t CaCO <sub>3</sub> /kt
Acid Potential	18	t CaCO <sub>3</sub> /kt
Neutralization Potential	3	t CaCO <sub>3</sub> /kt
Sulfur	0.61	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.59	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	0.3	%
Sulfur Acid Potential	0.59	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

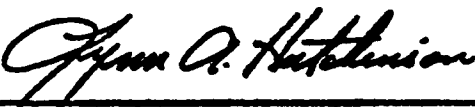
SAMPLE DESCRIPTION: TL960237

SAMPLE ID NUMBER: AF01399

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-28	t CaCO <sub>3</sub> /kt
Acid Potential	45	t CaCO <sub>3</sub> /kt
Neutralization Potential	17	t CaCO <sub>3</sub> /kt
Sulfur	1.49	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.45	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.7	%
Sulfur Acid Potential	1.45	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department


SAMPLE DESCRIPTION: TL960238

SAMPLE ID NUMBER: AF01400

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	11	t CaCO <sub>3</sub> /kt
Acid Potential	9	t CaCO <sub>3</sub> /kt
Neutralization Potential	20	t CaCO <sub>3</sub> /kt
Sulfur	0.54	%
HCL Extractable Sulfur	0.23	%
HNO <sub>3</sub> Extractable Sulfur	0.28	%
Sulfur Residual	0.03	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.6	%
Sulfur Acid Potential	0.28	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960239

SAMPLE ID NUMBER: AF01401

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	2	t CaCO <sub>3</sub> /kt
Acid Potential	7	t CaCO <sub>3</sub> /kt
Neutralization Potential	9	t CaCO <sub>3</sub> /kt
Sulfur	0.27	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.22	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	0.9	%
Sulfur Acid Potential	0.22	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121

**CERTIFICATE OF ANALYSIS**

**05/14/97**

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

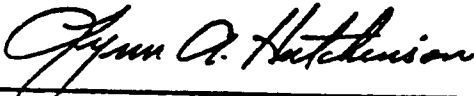
SAMPLE DESCRIPTION: TL960240

SAMPLE ID NUMBER: AF01402

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	8	t CaCO <sub>3</sub> /kt
Acid Potential	18	t CaCO <sub>3</sub> /kt
Neutralization Potential	26	t CaCO <sub>3</sub> /kt
Sulfur	0.61	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.57	%
Sulfur Residual	0.04	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2.6	%
Sulfur Acid Potential	0.57	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960241

SAMPLE ID NUMBER: AF01403

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	93	t CaCO <sub>3</sub> /kt
Acid Potential	7	t CaCO <sub>3</sub> /kt
Neutralization Potential	100	t CaCO <sub>3</sub> /kt
Sulfur	0.31	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.21	%
Sulfur Residual	0.10	%
Moisture %H <sub>2</sub> O	<1	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	10	%
Sulfur Acid Potential	0.21	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: HYDROMET 12/17/96

SAMPLE ID NUMBER: AF02239

Project: Acid/Base Accounting

COLLECTION DATE: 12/17/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	233	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	233	t CaCO <sub>3</sub> /kt
Sulfur	6.56	%
HCL Extractable Sulfur	6.35	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	0.21	%
Moisture %H <sub>2</sub> O	PENDING	%
Soil Paste Conductivity	14270	umhos/cm
pH Paste	8.16	
Neut. Pot. as % CaCO <sub>3</sub>	23.3	%
Sulfur Acid Potential	NOT DETECTED	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960146 DUP

SAMPLE ID NUMBER: AF01290

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	6	t CaCO <sub>3</sub> /kt
Acid Potential	11	t CaCO <sub>3</sub> /kt
Neutralization Potential	17	t CaCO <sub>3</sub> /kt
Sulfur	0.47	%
HCL Extractable Sulfur	0.11	%
HNO <sub>3</sub> Extractable Sulfur	0.34	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity	3700	umhos/cm
pH Paste	7.19	
Neut. Pot. as % CaCO <sub>3</sub>	1.7	%
Sulfur Acid Potential	0.34	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

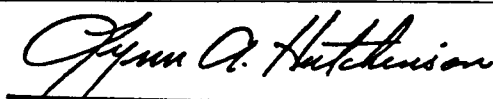
SAMPLE DESCRIPTION: TL960157 DUP

SAMPLE ID NUMBER: AF01303

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	62	t CaCO <sub>3</sub> /kt
Acid Potential	4	t CaCO <sub>3</sub> /kt
Neutralization Potential	66	t CaCO <sub>3</sub> /kt
Sulfur	0.28	%
HCL Extractable Sulfur	0.02	%
HNO <sub>3</sub> Extractable Sulfur	0.14	%
Sulfur Residual	0.12	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	6.6	%
Sulfur Acid Potential	0.14	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

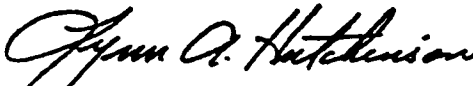
SAMPLE DESCRIPTION: TL960173 DUP

SAMPLE ID NUMBER: AF01321

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-13	t CaCO <sub>3</sub> /kt
Acid Potential	46	t CaCO <sub>3</sub> /kt
Neutralization Potential	33	t CaCO <sub>3</sub> /kt
Sulfur	1.65	%
HCL Extractable Sulfur	0.15	%
HNO <sub>3</sub> Extractable Sulfur	1.47	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	3.3	%
Sulfur Acid Potential	1.47	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

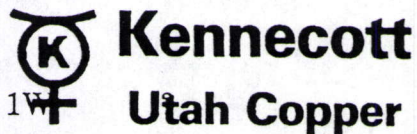
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

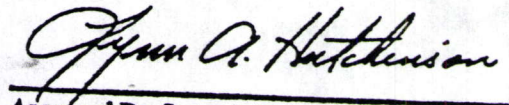
SAMPLE DESCRIPTION: TL960188 DUP

SAMPLE ID NUMBER: AF01339

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-14	t CaCO <sub>3</sub> /kt
Acid Potential	34	t CaCO <sub>3</sub> /kt
Neutralization Potential	20	t CaCO <sub>3</sub> /kt
Sulfur	1.15	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	1.10	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	2	%
Sulfur Acid Potential	1.10	%

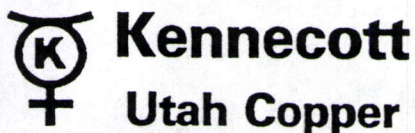
  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960203 DUP

SAMPLE ID NUMBER: AF01357

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	6	t CaCO <sub>3</sub> /kt
Acid Potential	9	t CaCO <sub>3</sub> /kt
Neutralization Potential	15	t CaCO <sub>3</sub> /kt
Sulfur	0.42	%
HCL Extractable Sulfur	0.07	%
HNO <sub>3</sub> Extractable Sulfur	0.30	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.5	%
Sulfur Acid Potential	0.30	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960218 DUP

SAMPLE ID NUMBER: AF01375

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	-4	t CaCO <sub>3</sub> /kt
Acid Potential	23	t CaCO <sub>3</sub> /kt
Neutralization Potential	19	t CaCO <sub>3</sub> /kt
Sulfur	1.03	%
HCL Extractable Sulfur	0.25	%
HNO <sub>3</sub> Extractable Sulfur	0.72	%
Sulfur Residual	0.05	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	1.9	%
Sulfur Acid Potential	0.72	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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Environmental Laboratory  
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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960226 DUP

SAMPLE ID NUMBER: AF01386

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	64	t CaCO <sub>3</sub> /kt
Acid Potential	INSUFFCNT SMPL	t CaCO <sub>3</sub> /kt
Neutralization Potential	64	t CaCO <sub>3</sub> /kt
Sulfur	0.26	%
HCL Extractable Sulfur	INSUFFCNT SMPL	%
HNO <sub>3</sub> Extractable Sulfur	INSUFFCNT SMPL	%
Sulfur Residual	INSUFFCNT SMPL	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	6.4	%
Sulfur Acid Potential	INSUFFCNT SMPL	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: TL960241 DUP

SAMPLE ID NUMBER: AF01404

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	99	t CaCO <sub>3</sub> /kt
Acid Potential	INSUFFCNT SMPL	t CaCO <sub>3</sub> /kt
Neutralization Potential	99	t CaCO <sub>3</sub> /kt
Sulfur	0.27	%
HCL Extractable Sulfur	INSUFFCNT SMPL	%
HNO <sub>3</sub> Extractable Sulfur	INSUFFCNT SMPL	%
Sulfur Residual	INSUFFCNT SMPL	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	9.9	%
Sulfur Acid Potential	INSUFFCNT SMPL	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: HYDROMET 12/17/96 DUP

SAMPLE ID NUMBER: AF02261

Project: Acid/Base Accounting

COLLECTION DATE: 02/10/97

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	235	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	235	t CaCO <sub>3</sub> /kt
Sulfur	6.56	%
HCL Extractable Sulfur	6.50	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	0.06	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity	14270	umhos/cm
pH Paste	8.16	
Neut. Pot. as % CaCO <sub>3</sub>	23.5	%
Sulfur Acid Potential	NOT DETECTED	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

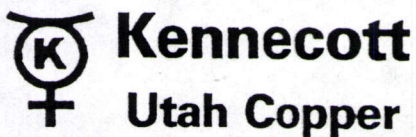
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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9600 West 2100 South  
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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

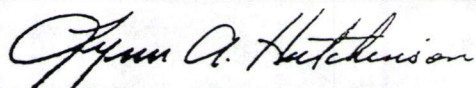
SAMPLE DESCRIPTION: QCABA-REF GMT

SAMPLE ID NUMBER: AF00198

Project: Acid/Base Accounting

COLLECTION DATE: 01/07/97

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	42	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	48	t CaCO <sub>3</sub> /kt
Sulfur	0.23	%
HCL Extractable Sulfur	0.04	%
HNO <sub>3</sub> Extractable Sulfur	0.18	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity	440	umhos/cm
pH Paste	8.49	
Neut. Pot. as % CaCO <sub>3</sub>	4.8	%
Sulfur Acid Potential	0.18	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

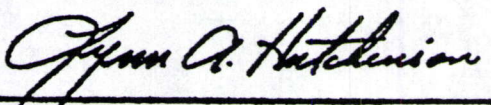
SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01291

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	42	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	48	t CaCO <sub>3</sub> /kt
Sulfur	0.24	%
HCL Extractable Sulfur	0.03	%
HNO <sub>3</sub> Extractable Sulfur	0.19	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity	450	umhos/cm
pH Paste	8.5	
Neut. Pot. as % CaCO <sub>3</sub>	4.8	%
Sulfur Acid Potential	0.19	%

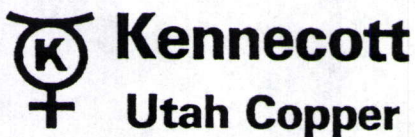
  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01305

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	42	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	48	t CaCO <sub>3</sub> /kt
Sulfur	0.29	%
HCL Extractable Sulfur	0.09	%
HNO <sub>3</sub> Extractable Sulfur	0.18	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	4.8	%
Sulfur Acid Potential	0.18	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

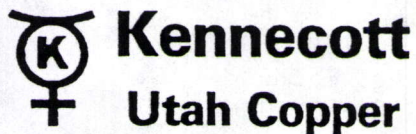
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
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Magna, Utah 84044-6001  
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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

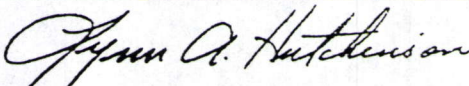
SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01323

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	51	t CaCO <sub>3</sub> /kt
Acid Potential	1	t CaCO <sub>3</sub> /kt
Neutralization Potential	52	t CaCO <sub>3</sub> /kt
Sulfur	0.25	%
HCL Extractable Sulfur	0.22	%
HNO <sub>3</sub> Extractable Sulfur	0.02	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	5.2	%
Sulfur Acid Potential	0.02	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01341

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	42	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	48	t CaCO <sub>3</sub> /kt
Sulfur	0.24	%
HCL Extractable Sulfur	0.02	%
HNO <sub>3</sub> Extractable Sulfur	0.20	%
Sulfur Residual	0.02	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	4.8	%
Sulfur Acid Potential	0.20	%

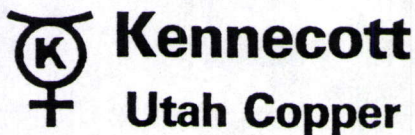
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

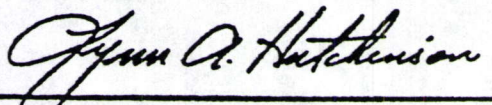
SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01359

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	43	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	49	t CaCO <sub>3</sub> /kt
Sulfur	0.23	%
HCL Extractable Sulfur	0.01	%
HNO <sub>3</sub> Extractable Sulfur	0.20	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	4.9	%
Sulfur Acid Potential	0.20	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01377

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	38	t CaCO <sub>3</sub> /kt
Acid Potential	8	t CaCO <sub>3</sub> /kt
Neutralization Potential	46	t CaCO <sub>3</sub> /kt
Sulfur	0.27	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	0.26	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	4.6	%
Sulfur Acid Potential	0.26	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01388

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	44	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	50	t CaCO <sub>3</sub> /kt
Sulfur	0.22	%
HCL Extractable Sulfur	0.02	%
HNO <sub>3</sub> Extractable Sulfur	0.20	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	5	%
Sulfur Acid Potential	0.20	%

  
Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

05/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01406

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	44	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	50	t CaCO <sub>3</sub> /kt
Sulfur	0.24	%
HCL Extractable Sulfur	0.04	%
HNO <sub>3</sub> Extractable Sulfur	0.20	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	5	%
Sulfur Acid Potential	0.20	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCl Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF01945

Project: Acid/Base Accounting

COLLECTION DATE: 02/03/97

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	40	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	46	t CaCO <sub>3</sub> /kt
Sulfur	0.24	%
HCL Extractable Sulfur	0.04	%
HNO <sub>3</sub> Extractable Sulfur	0.19	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	Not Analyzed	%
Soil Paste Conductivity	450	umhos/cm
pH Paste	8.51	
Neut. Pot. as % CaCO <sub>3</sub>	4.6	%
Sulfur Acid Potential	0.19	%

A handwritten signature in cursive script, reading 'Lynn A. Hutchinson'.

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
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9600 West 2100 South  
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(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF02045

Project: Acid/Base Accounting

COLLECTION DATE: 02/04/97

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	48	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	54	t CaCO <sub>3</sub> /kt
Sulfur	0.23	%
HCL Extractable Sulfur	0.02	%
HNO <sub>3</sub> Extractable Sulfur	0.19	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	Not Analyzed	%
Soil Paste Conductivity	450	umhos/cm
pH Paste	8.51	
Neut. Pot. as % CaCO <sub>3</sub>	5.4	%
Sulfur Acid Potential	0.19	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03

Reference: Modified SOBEK

Sulfate Sulfur = HCL Extractable Sulfur

Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019

State of Utah: E-24

American Industrial Hygiene Association: 121



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Environmental Laboratory  
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Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/14/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: REF GMT

SAMPLE ID NUMBER: AF02263

Project: Acid/Base Accounting

COLLECTION DATE: 02/10/97

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	47	t CaCO <sub>3</sub> /kt
Acid Potential	6	t CaCO <sub>3</sub> /kt
Neutralization Potential	53	t CaCO <sub>3</sub> /kt
Sulfur	0.25	%
HCL Extractable Sulfur	0.04	%
HNO <sub>3</sub> Extractable Sulfur	0.2	%
Sulfur Residual	0.01	%
Moisture %H <sub>2</sub> O	Not Analyzed	%
Soil Paste Conductivity	450	umhos/cm
pH Paste	8.51	
Neut. Pot. as % CaCO <sub>3</sub>	5.3	%
Sulfur Acid Potential	0.2	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01289

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	NOT ANALYZED	%
Soil Paste Conductivity	3	umhos/cm
pH Paste	5.7	
Neut. Pot. as % CaCO <sub>3</sub>	< 0.02	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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Environmental Laboratory  
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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01304

Project: Acid/Base Accounting

COLLECTION DATE: 10/09/96

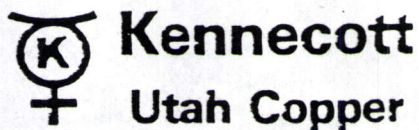
<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	NOT ANALYZED	%
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01322

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01340

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

Approved By: Lynn A. Hutchinson CIH  
KEL Laboratory Director

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
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9600 West 2100 South  
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(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01358

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



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FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01376

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01387

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01405

Project: Acid/Base Accounting

COLLECTION DATE: 10/14/96

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O		
Soil Paste Conductivity		
pH Paste		
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCl Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF01944

Project: Acid/Base Accounting

COLLECTION DATE: 02/03/97

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	< 0.05	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	NOT ANALYZED	%
Soil Paste Conductivity	NOT ANALYZED	umhos/cm
pH Paste	5.8	
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121



Kennecott Utah Copper  
Environmental Laboratory  
9600 West 2100 South  
Magna, Utah 84044-6001  
(801) 569-7950  
FAX: (801) 569-7901

## CERTIFICATE OF ANALYSIS

04/02/97

TO: Dr. Richard L. Jones  
Utah Copper Environmental Department

SAMPLE DESCRIPTION: BLANK

SAMPLE ID NUMBER: AF02262

Project: Acid/Base Accounting

COLLECTION DATE: 02/10/97

<u>PARAMETER</u>	<u>RESULT</u>	<u>UNITS</u>
ABA Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Acid Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Neutralization Potential	NOT DETECTED	t CaCO <sub>3</sub> /kt
Sulfur	NOT DETECTED	%
HCL Extractable Sulfur	NOT DETECTED	%
HNO <sub>3</sub> Extractable Sulfur	NOT DETECTED	%
Sulfur Residual	NOT DETECTED	%
Moisture %H <sub>2</sub> O	NOT ANALYZED	%
Soil Paste Conductivity	NOT ANALYZED	umhos/cm
pH Paste	5.8	
Neut. Pot. as % CaCO <sub>3</sub>	< 0.2	%
Sulfur Acid Potential	NOT DETECTED	%

### Methods:

Samples Analyzed by KEL SOP 5010.03  
Reference: Modified SOBEK  
Sulfate Sulfur = HCL Extractable Sulfur  
Pyritic Sulfur = HNO<sub>3</sub> Extractable Sulfur

### Laboratory Certifications:

USEPA: UT019  
State of Utah: E-24  
American Industrial Hygiene Association: 121

**APPENDIX B**

**CERTIFICATES OF ANALYSIS:  
ENERGY LABORATORIES, INC.**

**ENERGY LABORATORIES, INC.**

P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325  
FAX (406) 252-6069 • 1-800-735-4489

**LABORATORY REPORT**

**TO:** Michael Shields  
**ADDRESS:** Shepherd Miller, Inc.  
3801 Automation Way #100  
Ft. Collins, CO 80525

**LAB NO.:** 96-60981-61004

**DATE:** 10/22/96 az

**SOIL ANALYSIS**

Proj. #02-374/3, Kennecott  
Submitted 10/14/96

Sample No. Location	60981 <u>AT2-L</u>	60982 <u>AT1-U</u>	60983 <u>AT1-L</u>	60984 <u>AT3-L</u>	60985 <u>AT3-U</u>	60986 <u>AT4-L</u>	60987 <u>AT5-L</u>
Lime, % as CaCO <sub>3</sub>	7.8	1.6	<0.1	0.2	1.1	1.5	0.8
Total Sulfur, %	0.74	2.84	0.69	1.08	0.60	1.00	0.42
Hot H <sub>2</sub> O Extractable Sulfur, %	0.34	<0.01	0.45	0.61	0.13	0.23	0.27
HCl Extractable Sulfur, %	0.04	0.12	0.10	0.13	<0.01	<0.01	0.09
HNO <sub>3</sub> Extractable Sulfur, %	0.34	2.47	0.14	0.31	0.30	0.69	0.06
Residual Sulfur, %	0.02	0.25	<0.01	0.03	0.17	0.08	<0.01

ISS—Insufficient Sample

**ENERGY LABORATORIES, INC.**

P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325  
FAX (406) 252-6069 • 1-800-735-4489

**LABORATORY REPORT**

TO: Michael Shields  
ADDRESS: Shepherd Miller, Inc.  
3801 Automation Way #100  
Ft. Collins, CO 80525

LAB NO.: 96-60981-61004  
DATE: 10/22/96 az

**SOIL ANALYSIS**

Proj. #02-374/3, Kennecott  
Submitted 10/14/96

Sample No. Location	60988 <u>AT5-U</u>	60989 <u>AT6-L</u>	60990 <u>AT7-L</u>	60991 <u>SA-1</u>	60992 <u>SM1-1</u>	60993 <u>ST1 -U</u>	60994 <u>AT14-U</u>
Lime, % as CaCO <sub>3</sub>	4.9	1.5	6.3	ISS	2.5	3.1	3.1
Total Sulfur, %	1.75	0.88	0.85	0.30	0.73	2.42	2.49
Hot H <sub>2</sub> O Extractable Sulfur, %	0.23	0.06	0.52	0.02	0.13	0.07	0.31
HCl Extractable Sulfur, %	0.01	0.05	<0.01	<0.01	0.01	0.02	0.04
HNO <sub>3</sub> Extractable Sulfur, %	1.41	0.69	0.31	0.11	0.56	2.21	2.00
Residual Sulfur, %	0.10	0.08	0.02	0.17	0.03	0.12	0.14

ISS—Insufficient Sample

**ENERGY LABORATORIES, INC.**

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FAX (406) 252-6069 • 1-800-735-4489

**LABORATORY REPORT**

TO: Michael Shields  
ADDRESS: Shepherd Miller, Inc.  
3801 Automation Way #100  
Ft. Collins, CO 80525

LAB NO.: 96-60981-61004  
DATE: 10/22/96 az

**SOIL ANALYSIS**

Proj. #02-374/3, Kennecott  
Submitted 10/14/96

Sample No. Location	60995 <u>AT13-U</u>	60996 <u>AT13-M</u>	60997 <u>AT12-M</u>	60998 <u>AT11-L</u>	60999 <u>AT9-L</u>	61000 <u>AT11-U</u>	61001 <u>AT10-U</u>
Lime, % as CaCO <sub>3</sub>	2.3	1.9	1.8	<0.1	1.4	1.8	1.8
Total Sulfur, %	0.73	2.99	0.85	0.83	0.76	1.34	0.62
Hot H <sub>2</sub> O Extractable Sulfur, %	0.06	0.05	0.06	0.37	0.10	0.11	0.15
HCl Extractable Sulfur, %	<0.01	0.20	0.04	0.19	<0.01	<0.01	<0.01
HNO <sub>3</sub> Extractable Sulfur, %	0.63	2.59	0.71	0.27	0.57	1.16	0.41
Residual Sulfur, %	0.04	0.15	0.04	<0.01	0.09	0.07	0.06

ISS—Insufficient Sample

**ENERGY LABORATORIES, INC.**

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FAX (406) 252-6069 • 1-800-735-4489

**LABORATORY REPORT**

TO: Michael Shields  
ADDRESS: Shepherd Miller, Inc.  
3801 Automation Way #100  
Ft. Collins, CO 80525

LAB NO.: 96-60981-61004  
DATE: 10/22/96 az

**SOIL ANALYSIS**

Proj. #02-374/3, Kennecott  
Submitted 10/14/96

Sample No. Location	61002 <u>AT9-U</u>	61003 <u>AT8-L</u>	61004 <u>AT7-U</u>
Lime, % as CaCO <sub>3</sub>	1.8	1.9	2.8
Total Sulfur, %	0.62	2.16	0.77
Hot H <sub>2</sub> O Extractable Sulfur, %	0.13	0.34	0.09
HCl Extractable Sulfur, %	<0.01	0.11	<0.01
HNO <sub>3</sub> Extractable Sulfur, %	0.44	1.64	0.63
Residual Sulfur, %	0.05	0.07	0.05

ISS—Insufficient Sample

**ENERGY LABORATORIES, INC.**

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FAX (406) 252-6069 • 1-800-735-4489

**LABORATORY REPORT**

**TO:** Michael Shields  
**ADDRESS:** Shepherd Miller, Inc.  
3801 Automation Way #100  
Ft. Collins, CO 80525

**LAB NO.:** 96-60990, 1000 dup  
**DATE:** 10/22/96 az

**SOIL ANALYSIS**

Proj. #02-374/3, Kennecott  
Submitted 10/14/96

Sample No. Location	60990DUP <u>AT7-L</u>	61000DUP <u>AT11-U</u>
Lime, % as CaCO <sub>3</sub>	6.8	2.0
Total Sulfur, %	0.83	1.36
Hot H <sub>2</sub> O Extractable Sulfur, %	0.53	0.07
HCl Extractable Sulfur, %	<0.01	<0.01
HNO <sub>3</sub> Extractable Sulfur, %	0.28	1.21
Residual Sulfur, %	0.02	0.08

ISS—Insufficient Sample

**ENERGY LABORATORIES, INC.**

P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325  
FAX (406) 252-6069 • 1-800-735-4489

**LABORATORY REPORT**

TO: Michael Shields  
ADDRESS: Shepherd Miller, Inc.  
3801 Automation Way #100  
Ft. Collins, CO 80525

LAB NO.: 96-60981-61004  
DATE: 10/22/96 az

**QUALITY ASSURANCE CONTROL SOIL ANALYSIS**

This Quality Assurance Control Soil Analysis was run with  
Lab Nos. 96-60981 through 96-61004 with the following results:

Sample No. ocation	<u>CONTROL SOIL ANALYSIS</u>	<u>TARGET RANGE</u>
Lime, % as CaCO <sub>3</sub>	7.0	4.0 – 8.4
Total Sulfur, %	0.22	0.10 – 0.31
Hot H <sub>2</sub> O Extractable Sulfur, %	0.02	0.01 – 0.06
HCl Extractable Sulfur, %	<0.01	<0.01
HNO <sub>3</sub> Extractable Sulfur, %	0.18	0.09 – 0.32
Residual Sulfur, %	0.02	0.01 – 0.07

ISS—Insufficient Sample

Lab Nos.: 96-60981 - 96-61004

Date: 14-OCT-96

Received by: Kathi Renier

Logged In by: Kathi Renier

### SAMPLE CONDITION QA/QC REPORT

This report provides information about the condition of the sample(s)  
and associated sample custody information on receipt at the laboratory.

Chain of Custody Form

Completed & Signed

Yes Comments: \_\_\_\_\_

Chain of Custody Seal

No Comments: \_\_\_\_\_

Intact

N/A Comments: \_\_\_\_\_

Signature Match Chain of Custody vs. Seal

N/A Comments: \_\_\_\_\_

Samples Received Cold

No Comments: \_\_\_\_\_

Samples Received Within Holding Time

Yes Comments: \_\_\_\_\_

Samples Received in Proper Containers

Yes Comments: \_\_\_\_\_

Samples Received Properly Preserved

N/A Comments: \_\_\_\_\_

Samples requiring analysis for volatile organics are tested for proper preservation at the time of analysis.

Any preservation problems encountered for these samples are noted on the analytical parameter report pages.

Client notified about sample discrepancies:

Who: \_\_\_\_\_ By: \_\_\_\_\_ Date/Time: \_\_\_\_\_

Method of Shipping: UPS

Additional comments: \_\_\_\_\_



# SHEPHERD MILLER INCORPORATED

1801 Automation Way #100, Ft Collins, CO 80525 (970) 223-9600  
2460 W 26th Ave. #430-C, Denver, CO 80211-5307 (303) 477-5338  
1325 Airmotive Way #225, Reno, NV 89502 (702) 323-3407

Client/Project Name: Kennecott  
Project Number: 02-374/3

## CHAIN OF CUSTODY RECORD

Serial Number: \_\_\_\_\_

Page 1 of 3

SMI Contact/Phone Number: Mike Shields (970) 223-9600

Sampler(s). (Print Name/Signature/Affiliation)

*Mike Shields / SMI*

Matrix Codes:

SW-Surface Water

GW-Ground Water

S-soil/Sediment

To

Energy Labs

1120 South 27th St.

Billings, MT 59107

Sample Identification	Date	Time	Matrix	Number of Containers	Preservative(s)							Analyses Requested				Remarks								
					Unpreserved (12c only) Filtered?	Y	N	HNO <sub>3</sub> Filtered?	Y	N	HCl Filtered?	Y	N	H <sub>2</sub> SO <sub>4</sub> Filtered?	Y		N	NaOH Filtered?	Y	N	Other	Filtered?	Y	N
1. AT2-L	9/14/96		S	1																				
2. AT1-U	9/14/96			2																				
3. AT1-L	9/14/96																							
4. AT3-L																								
5. AT3-U																								
6. AT4-L																								
7. AT5-L																								
8. AT5-U																								
9. AT6-L	9/12/96																							
10. AT7-L	9/14/96																							

Relinquished by (Print Name/Affiliation) <i>Mike Shields / SMI</i>	Date: 10/14/96	Received by (Print Name/Affiliation) <i>Kathi Ronner / Energy Labs</i>	Date: 10/14/96	Laboratory use only:
Signature	Time:	Signature:	Time:	
Relinquished by (Print Name/Affiliation)	Date:	Received by (Print Name/Affiliation)	Date:	Condition/Temperature of Samples When Received:
Signature	Time:	Signature:	Time:	
Relinquished by (Print Name/Affiliation)	Date:	Received by (Print Name/Affiliation)	Date:	
Signature	Time:	Signature:	Time:	

Delivery Method/Shipping Document Number: \_\_\_\_\_

White: Return to SMI Yellow: Laboratory Pink: Field Team



# SHEPHERD MILLER INCORPORATED

1801 Automation Way #100, Ft Collins, CO 80525 (970) 223-9600  
2460 W 26th Ave. #430-C, Denver, CO 80211-5307 (303) 477-5338  
1325 Airmotive Way #225, Reno, NV 89502 (702) 323-3407

Client/Project Name: Kennecott

Project Number: 02-374/3

## CHAIN OF CUSTODY RECORD

Serial Number: \_\_\_\_\_

Page 2 of 3

SMI Contact/Phone Number: Mike Shields (970) 223-9600

Sampler(s): (Print Name/Signature/Affiliation)

*mu ell / smi*

Matrix Codes:

SW-Surface Water

GW-Ground Water

S-soil/Sediment

To

Energy Labs

1120 South 27th St.

Billings, MT 59107

Sample Identification	Date	Time	Matrix	Number of Containers	Preservative(s)							Other	Analyses Requested	Remarks	
					Unpreserved (See only) Filtered? Y N	HNO <sub>3</sub> Filtered? Y N	HCl Filtered? Y N	H <sub>2</sub> SO <sub>4</sub> Filtered? Y N	NaOH Filtered? Y N	Filtered? Y N					
1 SA-1	9/12/06		S	1									Sulfur Forms		
2 SMI-1															
3 ST11-U															
4 AT14-U															
5 AT13-U															
6 AT13-M															
7 AT12-M															
8 AT11-L															
9 AT9-L															
10 AT11-U															

Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	Laboratory use only:
<i>mu ell</i>	10/11/06			
Signature	Time:	Signature:	Time:	Condition/Temperature of Samples When Received:
Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	
Signature	Time:	Signature:	Time:	
Relinquished by: (Print Name/Affiliation)	Date:	Received by: (Print Name/Affiliation)	Date:	
Signature:	Time:	Signature:	Time:	

Delivery Method/Shipping Document Number: \_\_\_\_\_

White: Return to SMI Yellow: Laboratory Pink: Field Team



# SHEPHERD MILLER INCORPORATED

3801 Automation Way #100, Ft Collins, CO 80525 (970) 223-9600

2460 W 26th Ave #430-C, Denver, CO 80211-5307 (303) 477-5338

1325 Airmotive Way #225, Reno, NV 89502 (702) 323-3407

Client/Project Name: Kennecott

Project Number: 02-374/3

## CHAIN OF CUSTODY RECORD

Serial Number: \_\_\_\_\_

Page 3 of 3

SMI Contact/Phone Number: Mike Shields (970) 223-9600

Sampler(s): (Print Name/Signature/Affiliation)

*mu ell sm*

Matrix Codes:

SW-Surface Water

GW-Ground Water

S-soil/Sediment

To

Energy Labs

1120 South 27th St.

Billings, MT 59107

Sample Identification	Date	Time	Matrix	Number of Containers	Preservative(s)						Analyses Requested		Remarks
					Unpreserved (for only) Filtered? Y N	HNO <sub>3</sub> Filtered? Y N	HCl Filtered? Y N	H <sub>2</sub> SO <sub>4</sub> Filtered? Y N	NaOH Filtered? Y N	Other Filtered? Y N			
1 AT10-U	9/12/96		S	1									
2 AT9-U	{		S	S									
3 AT8-U			S	S									
4 AT7-U			S	S									
5													
6													
7													
8													
9													
10													

Relinquished by (Print Name/Affiliation)

*mu ell*

Signature

Relinquished by (Print Name/Affiliation)

Signature

Relinquished by (Print Name/Affiliation)

Signature

Date

10/11/96

Time

Date

Time

Date

Time

Received by (Print Name/Affiliation)

Signature

Received by (Print Name/Affiliation)

Signature

Received by (Print Name/Affiliation)

Signature

Date

Time

Date

Time

Date

Time

Laboratory use only

Condition/Temperature of Samples When Received.

Delivery Method/Shipping Document Number: \_\_\_\_\_

White Return to SMI Yellow Laboratory Pink Field Team

**APPENDIX C**

**QUALITY ASSURANCE/QUALITY CONTROL  
ACID-BASE ACCOUNTING**

**APPENDIX C**  
**QUALITY ASSURANCE/QUALITY CONTROL**  
**ACID-BASE ACCOUNTING**

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## 1.0 INTRODUCTION

An important component of any testing program is the implementation of measures to evaluate both the precision and accuracy of the tests being performed. To meet this objective for this project, quality assurance and quality control (QA/QC) samples were analyzed with the unknown samples.

Both Shepherd Miller, Inc. (SMI) and Schafer and Associates (SA) submitted separate batches of blind QA/QC samples to Kennecott Environmental Laboratory (KEL) for analysis of total sulfur, pyritic sulfur, and percent equivalent  $\text{CaCO}_3$  (% eq.  $\text{CaCO}_3$ ). These samples are summarized in Table 1. Included with the primary samples were splits of samples (1 for every 10 samples), two different reference samples (1 of each for every 10 samples), and blanks (1 for every 10 samples).

In addition to the above QA/QC measures, a total of 23 samples were split and analyzed for the same parameters by Energy Laboratories, Inc. (ELI) (Billings, MT). Included with the unknown samples sent to ELI were splits of unknown samples (1 for every 10 samples), and two different reference samples (1 of each for every 10 samples). No blanks were submitted to ELI for analysis.

As part of its internal QA/QC program, each laboratory also included its own internal QA/QC samples. At KEL, one duplicate, one blank, and one reference sample were analyzed for every 15 unknown samples tested. ELI's internal QA/QC program includes a split for every ten and analysis of an internally prepared reference sample for every sample batch submitted.

Section 2 describes the QA/QC samples and the criteria used to evaluate them. Sections 3 and 4, respectively, discuss the results from analysis of the QA/QC samples for KEL and ELI. Section 5 discusses the inter-laboratory comparison sample results. Section 6 summarizes the QA/QC sample analysis results for this project, and Section 7 presents references for this report.

## **2.0 CRITERIA EVALUATED**

### **2.1 Laboratory Blanks**

No target analytes were found in the KEL blanks. Blank contamination, if found, would have been evaluated using U.S. Environmental Protection Agency functional guidelines (EPA, 1988), which specify that sample concentrations less than 5 times the amount detected in associated blanks be changed to non-detects at the reported concentrations.

### **2.2 Reference Samples**

Reference samples were analyzed for each analyte utilizing the same sample preparation, analytical methods, and QA/QC procedures as employed for the primary samples.

A total of three different materials were used as reference samples for this project. They are as follows:

#### **2.2.1 SMI Reference Material**

This reference material was prepared by SMI by homogenizing large quantities of coarse-grained tailings collected at the Kennecott tailings facility. This reference material has been analyzed a total of 22 times by ELI over the past several years as part of QA/QC protocol on various projects including the Kennecott tailings characterization project (SMI, 1995). The results have been used to develop a mean and a range of values for total sulfur, pyritic sulfur, and percent equivalent  $\text{CaCO}_3$ . A quality control chart utilizing the mean and plus or minus 1.5 standard deviations has been developed for this reference material.

#### **2.2.2 CANMET Reference Material**

This reference material was purchased from the Canadian Reference Materials Project (CANMET). This material has a certified value for total sulfur and a provisional value for neutralizing potential.

### 2.2.3 Kennecott GMT-1 Reference Material

Kennecott prepared GMT-1 reference material using whole tailings material from the Copperton Concentrator.

### 2.3 Replicate Samples

For replicates of routine analytical samples, relative percent difference values (RPDs) of  $\pm 35$  percent for solid samples are generally considered acceptable. RPDs are calculated as follows:

$$RPD = (X_1 - X_2) / X_m \times 100 \text{ percent}$$

where:

$X_1$  and  $X_2$  are the observed values for a sample and its replicate, respectively,

$X_m$  is the mean of the two observed values.

These criteria are used to evaluate laboratory replicate sample results only when both values are greater or equal to 5 times the method detection limit (MDL). A limit of 2x MDL will be used if either the sample or the replicate value is less than 5 times MDL (EPA, 1988).

### 3.0 QA/QC RESULTS - KEL

#### 3.1 Laboratory Blanks

All analyte concentrations for the KEL blank samples were reported as below the detectable limits.

#### 3.2 Reference Samples

KEL analyzed a total of four different reference materials. Two of these reference materials were prepared or obtained by SMI and submitted blind to KEL and two were prepared internally by KEL. The results of these analyses for each reference material are as follows:

##### 3.2.1 SMI Reference Tailings Material

This reference tailings material was analyzed a total of eight times by KEL (Table 2). The range of expected values for this material, which has been analyzed by ELI a total of 22 times over the past several years, is also presented in Table 2.

The reported values from KEL (Table 2) show good reproducibility of results for total sulfur ( $0.76 \pm 0.22$  percent), pyritic sulfur ( $0.61 \pm 0.28$  percent), and % eq.  $\text{CaCO}_3$  ( $2.64 \pm 0.19$  percent).

With respect to accuracy, analyses performed by KEL (Table 2) for pyritic and total sulfur are typically above the expected average obtained over a period of years for this material. For total sulfur, three of the seven samples analyzed are above the expected range of  $\pm 1.5$  standard deviations about the mean (0.54 to 0.70 percent total sulfur) and, for pyritic sulfur, three of the seven samples analyzed are above the expected range of  $\pm 1.5$  standard deviations about the mean (0.19 to 0.58 percent pyritic sulfur).

The reported values for percent pyritic sulfur and % eq.  $\text{CaCO}_3$  are within the expected range of values for this material.

### **3.2.2 CANMET Reference Material**

The CANMET reference material has a recommended value for percent total sulfur of  $0.298 \pm 0.015$  percent (95 percent confidence interval). Three of the six results for total sulfur were above the 95 percent confidence interval (Table 3).

The CANMET reference material does not have a reported value for pyritic sulfur.

The neutralization potential of the CANMET material has a provisional value of 5.2 % eq.  $\text{CaCO}_3$ . No confidence interval was reported for this parameter. All values reported by KEL were higher than the provisional value (Table 3).

### **3.2.3 Kennecott GMT-1 Reference Material**

This material was analyzed a total of 10 times by KEL (Table 4). The reported values show good reproducibility of results for total sulfur [ $0.24 \pm 0.015$  percent (average  $\pm 1$  standard deviation)] pyritic sulfur ( $0.20 \pm 0.024$  percent), and as % eq.  $\text{CaCO}_3$  ( $4.9 \pm 0.18$  percent).

The same reference sample was also used in a round-robin study performed by Kennecott involving nine separate laboratories, one of which was KEL. The reported values were  $0.24 \pm 0.024\%$  total sulfur,  $0.20 \pm 0.12\%$  pyritic sulfur, and  $4.7 \pm 1.24\%$  eq.  $\text{CaCO}_3$  which are in close agreement with KELs results.

### **3.3 Replicate (Split) Samples**

Replicate (split) samples were generated by SMI at a rate of one replicate for every 10 samples, resulting in the generation of six replicates. In addition, KEL produced one replicate for every 15 samples analyzed as part of their internal QA/QC program, which resulted in the generation of eight additional replicates for a total of 14 replicates.

The RPDs of five of the 14 sets of replicates were outside the acceptable range of  $\pm 35$  percent for percent total sulfur (Table 6), five of the 14 were outside the acceptable range for percent pyritic sulfur, and the RPDs of one set was outside the acceptable range for % eq.  $\text{CaCO}_3$ .

Samples that were outside the acceptable range of  $\pm 35\%$  were re-tested to validate the initial results. In most cases, the RPDs remained the same. The lack of acceptable QA/QC for a few samples may be the result of the "nugget effect"; sulfur in the tailings is present as individual grains of pyrite which may not be segregated out properly when samples are split for replicate analysis.

## **4.0 QA/QC RESULTS - ELI**

### **4.1 Reference Samples**

A total of three different reference materials were submitted to ELI along with the primary samples. In addition, ELI analyzes a internally prepared reference sample for every sample batch submitted. The results are as follows:

#### **4.1.1 SMI Tailings Reference Material**

This reference material was analyzed once by ELI (Table 2) as part of this project. The one reported value from ELI for this project had a higher than usual value for total sulfur (0.73 percent), which is slightly outside the expected range ( $\pm 1.5$  standard deviations) of 0.54 to 0.70 percent total sulfur.

The reported value for percent pyritic sulfur (0.56) is within the expected range of 0.19 to 0.58 percent pyritic sulfur but appears to be slightly higher than the average.

Percent eq.  $\text{CaCO}_3$  (2.5) is within the expected range of 2.0 to 2.8 % eq.  $\text{CaCO}_3$  as shown in Table 2.

#### **4.1.2 CANMET Reference Material**

The CANMET reference material has a recommended value for percent total sulfur of  $0.298 \pm 0.015$  percent. The one analysis performed by ELI on this material yielded a results (0.30 percent total sulfur) that was higher than the results from KEL (Table 3).

The CANMET reference does not have a reported value for pyritic sulfur.

The neutralizing potential of this standard was not measured due to insufficient sample sizes.

#### **4.1.3 GMT-1 Reference Material**

This material was analyzed once by ELI (Table 4). The reported values are consistent with those values measured by KEL.

#### **4.1.4 ELI reference Standard**

An in-house standard prepared by ELI was analyzed once with the samples submitted by SMI and once with the samples submitted by SA. As shown in Table 6, the results are all within the target range for each analyte.

### **4.2 Replicate (Split) Samples**

Replicate (split) samples were generated by SMI at a rate of one replicate for every 20 samples, resulting in the generation of one replicate. In addition, ELI produced one replicate for every 10 samples analyzed as part of their internal QA/QC program, which resulted in the generation of two replicates with the sampling batch submitted by SMI and one replicate with the sampling set submitted by SA.

The RPDs of the one replicate sample prepared by SMI was within  $\pm 35$  percent for percent total sulfur and percent pyritic sulfur (Table 7). The replicate sample was outside the acceptable range for % eq.  $\text{CaCO}_3$ .

The RPDs of the one replicate sample prepared by SA was within  $\pm 35$  percent for percent total sulfur, percent pyritic sulfur, and % eq.  $\text{CaCO}_3$  (Table 7).

The RPDs for the two replicate samples prepared by ELI were both within  $\pm 35$  percent for percent total sulfur, percent pyritic sulfur, and % eq.  $\text{CaCO}_3$  (Table 7).

## 5.0 INTER-LABORATORY COMPARISON

A total of 23 samples were split and analyzed by both KEL and ELI. The following evaluation is based on a relative percent difference (RPD) of  $\pm 35$  percent. The results are given in Table 8 and are summarized below:

- percent total sulfur 2 of 23 samples had RPD values greater than  $\pm 35$  percent
- percent pyritic sulfur 8 of 23 samples had RPD values greater than  $\pm 35$  percent
- % eq.  $\text{CaCO}_3$  4 of 23 samples had RPD values greater than  $\pm 35$  percent.

A comparison was performed on the population mean generated from each laboratory using student's t-test from the statistical package RRELSTAT (Lin, 1993) and the summary of statistics presented in Table 9. For all three parameters (total sulfur, pyritic sulfur, and % eq.  $\text{CaCO}_3$ ) there was no significant statistical difference in the population means at the 95% percent confidence level.

## 6.0 SUMMARY

Overall, the precision of the analyses conducted by KEL is acceptable due to the fact that:

1. Relative percent differences (RPDs) for sample splits were generally less than  $\pm 35\%$  for all components (total sulfur, pyritic sulfur, and equivalent  $\text{CaCO}_3$ ).
2. The analyses of the standards were within an acceptable range of values.

Visual examination of the test results from KEL for pyritic sulfur suggests that the values are lower than the same sample analyzed by ELI. However, application of the Student's t-test indicates that there is no statistical difference between the means of the two sets of analyses at the 95% confidence interval. The mean pyritic sulfur from the KEL analyses was  $1.1 \pm 0.68\%$  pyritic sulfur (mean  $\pm 1$  standard deviation), while the mean from ELI was  $1.2 \pm 0.70\%$  pyritic sulfur, corresponding to a difference in ABA units of 3 tons  $\text{CaCO}_3/\text{kton}$ .

Four of the 23 split samples analyses by both KEL and ELI had an RPD value greater than  $\pm 35\%$ . Application of the Student's t-test show that there is no statistical difference between the means of the two sets of analyses at the 95% confidence interval. Analyses performed by KEL had a mean value of  $2.1 \pm 2.1\%$  eq.  $\text{CaCO}_3$ , while the mean value for the same samples from ELI was  $2.4 \pm 1.8\%$  eq.  $\text{CaCO}_3$ , corresponding to a difference in ABA units of 3 tons  $\text{CaCO}_3/\text{kton}$ .

## 7.0 REFERENCES

- Lin, Phillip. 1993. Statistics for Sampling and Statistical Problems. U.S. Environmental Protection Agency, Office of Research and Development, Risk Reduction Engineering Laboratory, Cincinnati, OH.
- Shepherd Miller, Inc. and Schafer and Associates. 1995. *Acidification Potential of the Kennecott Tailings*, prepared for Kennecott Utah Copper Corp., May 18.
- U.S. Environmental Protection Agency (EPA). 1988. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis*, prepared for the Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, July.

**Table 1      Summary of primary and QA/QC samples submitted to ELI and KEL**

<b>Sample</b>	<b>Schafer and Associates</b>	<b>Shepherd Miller, Inc.</b>
<b>Primary</b>		
KEL	22	60
ELI	3	21
<b>QA/QC samples submitted blind to the lab</b>		
blank	1	5
replicate	0	6
<u>reference</u>		
SMI reference	2	5
CANMET	1	5
<b>Internal laboratory QA/QC samples (KEL)</b>		
blank	2	6
reference	2	6
replicate	2	6

**Table 2**      **Analytical results for reference sample prepared by Shepherd Miller, Inc.**

Sample Description	SMI/SA Sample ID	Analyzing Laboratory	Total Sulfur (%)	Pyritic Sulfur (%)	% eq. CaCO <sub>3</sub>
TL960183	REF-SMI	KEL	0.59	0.38	2.6
TL960197	REF-SMI	KEL	0.70	0.38	2.6
TL960211	REF-SMI	KEL	0.65	0.60	2.4
TL960225	REF-SMI	KEL	0.81	0.43	2.9
TL960240	REF-SMI	KEL	0.61	0.57	2.6
TL960154	plot 5A	KEL	0.76	0.71	2.7
TL960155	plot 5B	KEL	1.23	1.19	2.4
	REF-SMI	ELI	0.73 <sup>VI</sup>	0.56 <sup>VI</sup>	2.5
Average			0.76	0.61	2.64
Standard Deviation			0.22	0.28	0.19
Statistical values for reference sample based on previous analyses by ELI					
number of times analyzed			22	22	22
average			0.62	0.38	2.4
standard deviation			0.053	0.130	0.25
range (avg. $\pm$ 1.5 std dev.)			0.54-0.70	0.19-0.58	2.0-2.8

Note:

VI ELI data not included in statistics

**Table 3      Analytical results for CANMET reference sample**

Sample Description	SMI/SA Sample ID	Analyzing Laboratory	Total Sulfur (%)	Pyritic Sulfur (%)	% eq. CaCO <sub>3</sub>
TL960184	REF-SA	KEL	0.32	0.15	7.1
TL960198	REF-SA	KEL	0.31	0.20	5.9
TL960212	REF-SA	KEL	0.30	IS	7
TL960226	REF-SA	KEL	0.57	IS	6.5
TL960241	REF-SA	KEL	0.31	0.21	10
TL960157	plot 5D	KEL	0.32	0.18	6.2
--	SA-1	ELI	0.30 <sup>11</sup>	0.11 <sup>11</sup>	IS
Average			0.36	0.19	7.12
Standard Deviation			0.11	0.027	1.49
Recommended values for CANMET standard					
Mean			0.298	NA <sup>12</sup>	5.2 <sup>13</sup>
95% confidence limits			±0.015	NA	NA <sup>14</sup>

Notes:

- <sup>11</sup> data not included in statistics
- <sup>12</sup> not provided for pyrite content
- <sup>13</sup> considered only as a "provisional" value
- <sup>14</sup> not provided for % eq. CaCO<sub>3</sub>
- IS = insufficient sample for analysis
- NA = not analyzed

**Table 4      Analytical results for reference material GMT-1**

Analyzing Laboratory	Total Sulfur (%)	Pyritic Sulfur (%)	% eq. CaCO <sub>3</sub>
KEL	0.24	0.15	5.0
KEL	0.24	0.19	4.8
KEL	0.25	0.18	4.8
KEL	0.25	0.21	5.2
KEL	0.24	0.20	4.8
KEL	0.23	0.20	4.9
KEL	0.27	0.26	4.6
KEL	0.22	0.20	5.0
KEL	0.24	0.20	5.0
KEL	0.23	0.18	4.8
ELI	0.24 <sup>NI</sup>	0.16	4.5
Average	0.24	0.20	4.89
Standard Deviation	0.015	0.024	0.18

Note:

NI values not included in statistics

**Table 5 Replicate sample results for KEL**

Lab Sample Number	Sample Description	SMI/SA Sample ID	Total Sulfur (%)	Pyritic Sulfur (%)	% eq. CaCO <sub>3</sub>
AF01288	TL960146	stepback south 4-6	0.65	0.48	1.7
AF01290	TL960146 - dup		0.47	0.34	1.7
			RPD 32	10	0
AF01302	TL960157	plot 5D	0.32	0.18	6.2
AF01303	TL960157 - dup		0.28	0.14	6.6
			RPD 13	25	-6.2
AF01320	TL960173	AT4-M	1.60	1.46	3.5
AF01321	TL960173 - dup		1.65	1.47	3.3
			RPD -3.1	-0.68	5.9
AF01338	TL960188	AT12-U	1.29	1.23	1.9
AF01339	TL960188 - dup		1.15	1.10	2.0
			RPD 11	11	-5.1
AF01356	TL960203	AT6-L	1.10	0.21	1.2
AF01357	TL960203 - dup		0.42	0.30	1.5
			RPD 89	-35	-22
AF01374	TL960218	AT10-M	1.90	1.04	1.6
AF01375	TL960218 - dup		1.03	0.72	1.9
			RPD 59	36	-17
AF01385	TL960226	REF-SA	0.57	I.S.	6.5
AF01386	TL960226 - dup		0.26	I.S.	6.4
			RPD 75	--	1.6
AF01403	TL960241	REF-SA	0.31	0.21	10
AF01404	TL960241 - dup		0.27	I.S.	9.9
			RPD 14	--	1.0
AF01306	TL960159	AT1-U	1.66	0.17	1.1
AF01318	TL960171	AT1-U-DUP	2.49	2.03	1.5
			RPD -40	-170	-31

**Table 5 Replicate sample results for KEL (continued)**

Lab Sample Number	Sample Description	SMI/SA Sample ID	Total Sulfur (%)	Pyritic Sulfur (%)	% eq. CaCO <sub>3</sub>
AF01331	TL960181	AT13-U	0.78	0.26	2.2
AF01335	TL960185	AT13-U-DUP	0.76	0.52	2.5
			2.6	<b>-66</b>	<b>-13</b>
AF01342	TL960189	AT12-M	0.82	0.73	1.4
AF01352	TL960199	AT12-M-DUP	0.82	0.78	2.4
			RPD 0	-6.6	<b>-53</b>
AF01356	TL960203	AT6-L	1.1	0.21	1.2
AF01369	TL960213	AT6-L-DUP	0.61	0.55	1.5
			RPD 57	<b>-90</b>	<b>-22</b>
AF01373	TL960217	AT10-U	0.60	0.19	1.9
AF01382	TL960223	AT10-U-DUP	0.61	0.56	2.1
			RPD -1.6	<b>-99</b>	<b>-10</b>
AF01397	TL960235	TP2-8	0.29	0.21	1.1
AF01401	TL960239	TP2-8-DUP	0.27	0.22	0.90
			RPD 7.1	-4.7	20

Notes:

Bold numbers indicate RPD values greater than  $\pm 35\%$

"..." an RPD was not calculated for these analyses, the reported value is less than 4 times the method detection limit.

I.S = insufficient sample for analysis

**Table 6      Results of ELI internal QA/QC reference sample**

<b>Sampling Set</b>	<b>Total Sulfur</b>	<b>Pyritic Sulfur</b>	<b>% eq. CaCO<sub>3</sub></b>
SMI sampling set	0.22	0.18	7.0
Target Range	0.10-0.31	0.09-0.32	4.0-8.4
SA sampling set	0.28	0.17	7.4
Target Range	0.11-0.32	0.08-0.29	4.2-8.5

**Table 7      Results of replicate analyses performed by ELI**

<b>Sample ID</b>	<b>Total Sulfur (%)</b>	<b>Pyritic Sulfur (%)</b>	<b>% eq. CaCO<sub>3</sub></b>
<b>Replicate prepared by SMI</b>			
AT1-U	2.84	2.47	1.6
ST1-U	2.42	2.21	3.1
<b>RPD</b>	<b>16</b>	<b>11</b>	<b>64</b>
<b>Replicate prepared by SA</b>			
Hot Spot #4	1.48	0.56	1.0
Hot Spot #4-dup	1.48	0.56	1.0
<b>RPD</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Replicates prepared by ELI</b>			
AT7-L	0.83	0.28	6.8
AT7-L-dup	0.85	0.31	6.3
<b>RPD</b>	<b>2.4</b>	<b>10</b>	<b>7.6</b>
AT11-U	1.36	1.21	2.0
AT11-U-dup	1.34	1.16	1.8
<b>RPD</b>	<b>1.5</b>	<b>4.2</b>	<b>11</b>

**Table 8 Inter-laboratory comparison - KEL and ELI**

Sample Description	SMI/SA Sample ID	Lab.	Total Sulfur (%)	Pyritic Sulfur (%)	% eq. CaCO <sub>3</sub>
TL960164	AT2-L	ELI	0.74	0.34	7.8
	AT2-L	KEL	0.76	0.19	8.7
		RPD	-2.7	57	-11
TL960161	AT1-L	ELI	0.69	0.14	<0.1
	AT1-L	KEL	0.89	0.34	<0.2
		RPD	-25	-83	--
TL960167	AT3-L	ELI	1.08	0.31	0.2
	AT3-L	KEL	1.24	0.43	0.4
		RPD	-14	-32	--
TL960165	AT3-U	ELI	0.60	0.30	1.1
	AT3-U	KEL	0.42	0.28	0.7
		RPD	35	6.9	44
TL960168	AT4-L	ELI	1.00	0.69	1.5
	AT4-L	KEL	0.81	0.80	1.0
		RPD	61	-15	40
TL960177	AT5-L	ELI	0.42	0.06	0.8
	AT5-L	KEL	0.51	0.08	0.7
		RPD	-19	-29	13
TL960175	AT5-U	ELI	1.75	1.41	4.9
	AT5-U	KEL	1.74	0.51	3.5
		RPD	0.57	-6.8	33
TL960203	AT6-L	ELI	0.88	0.69	1.5
	AT6-L	KEL	1.1	0.21	1.2
		RPD	-22	107	22
TL960206	AT7-L	ELI	0.85	0.31	6.3
	AT7-L	KEL	0.76	0.22	6.5
		RPD	11	34	-3.1

**Table 8 Inter-laboratory comparison - KEL and ELI (continued)**

Sample Description	SMI/SA Sample ID	Lab.	Total Sulfur (%)	Pyritic Sulfur (%)	% eq. CaCO <sub>3</sub>
TL960178	AT14-U	ELI	2.49	2.00	3.1
	AT14-U	KEL	1.85	1.74	3.6
		RPD	29	14	-15
TL960181	AT13-U	ELI	0.73	0.63	2.3
	AT13-U	KEL	0.78	0.26	2.2
		RPD	-6.6	83	4.4
TL960182	AT13-M	ELI	2.99	2.59	1.9
	AT13-M	KEL	2.34	2.23	2.0
		RPD	24	15	-5.1
TL960189	AT12-M	ELI	0.85	0.71	1.8
	AT12-M	KEL	0.82	0.73	1.4
		RPD	3.6	-2.8	25
TL960222	AT11-L	ELI	0.83	0.27	<0.1
	AT11-L	KEL	0.71	0.19	<0.2
		RPD	16	35	--
TL960216	AT9-L	ELI	0.76	0.57	1.4
	AT9-L	KEL	0.80	0.54	1.4
		RPD	-5.1	5.4	0
TL960220	AT11-U	ELI	1.34	1.16	1.8
	AT11-U	KEL	0.95	0.83	1.6
		RPD	34	33	12
TL960217	AT10-U	ELI	0.62	0.41	1.8
	AT10-U	KEL	0.60	0.19	1.9
		RPD	3.3	73	-5.4
TL960210	AT9-U	ELI	0.62	0.44	1.8
	AT9-U	KEL	0.64	0.39	2.0
		RPD	-3.2	12	-11
TL960209	AT8-L	ELI	2.16	1.64	1.9
	AT8-L	KEL	2.08	1.04	1.6
		RPD	3.8	45	17

**Table 8 Inter-laboratory comparison - KEL and ELI (continued)**

Sample Description	SMI/SA Sample ID	Lab.	Total Sulfur (%)	Pyritic Sulfur (%)	% eq. CaCO <sub>3</sub>
TL960204	AT7-U	ELI	0.77	0.63	2.8
	AT7-U	KEL	0.80	0.76	1.9
		RPD	-3.8	-19	38
TL960141	hot spot 0-2	ELI	1.48	0.56	1.0
	hot spot 0-2	KEL	1.04	0.46	0.2
		RPD	35	-55	--
TL960142	hot spot 2-4	ELI	1.89	0.76	<0.2
	hot spot 2-4	KEL	1.82	0.97	<0.1
		RPD	43	24	--
TL960143	hot spot 4-6	ELI	0.35	0.29	1.3
	hot spot 4-6	KEL	3.36	0.88	0.2
		RPD	-162	-101	--

**Notes:**

Bold numbers indicate RPD values greater than  $\pm 35\%$

"--" an RPD was not calculated for these analyses, the reported value is less than 4 times the method detection limit.

**Table 9      Statistical comparison of results from KEL and ELI**

Statistics	Total Sulfur (%)		Pyritic Sulfur (%)		% eq. CaCO <sub>3</sub>	
	KEL	ELI	KEL	ELI	KEL	ELI
Average	1.13	1.18	0.74	0.69	2.14	2.35
Standard Deviation	0.676	0.700	0.615	0.541	2.06	1.84
Variance	0.478	0.512	0.396	0.306	4.46	3.58

This page is a reference page used to track documents internally for the Division of Oil, Gas and Mining

Mine Permit Number MO350015 Mine Name KUC Tailings T  
Operator Kennecott Utah Copper Date July 3, 1997  
TO \_\_\_\_\_ FROM \_\_\_\_\_

☐ CONFIDENTIAL ☐ BOND CLOSURE ☐ LARGE MAPS ☒ EXPANDABLE  
☐ MULTIPUL DOCUMENT TRACKING SHEET ☐ NEW APPROVED NOI  
☐ AMENDMENT ☐ OTHER \_\_\_\_\_

Description YEAR-Record Number

☐ NOI ☒ Incoming ☐ Outgoing ☐ Internal ☐ Superceded

Appendix A sampling Results

☐ NOI ☐ Incoming ☐ Outgoing ☐ Internal ☐ Superceded

☐ NOI ☐ Incoming ☐ Outgoing ☐ Internal ☐ Superceded

☐ NOI ☐ Incoming ☐ Outgoing ☐ Internal ☐ Superceded

☐ TEXT/ 8 1/2 X 11 MAP PAGES ☐ 11 X 17 MAPS ☐ LARGE MAP

COMMENTS: \_\_\_\_\_  
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\_\_\_\_\_  
CC: \_\_\_\_\_